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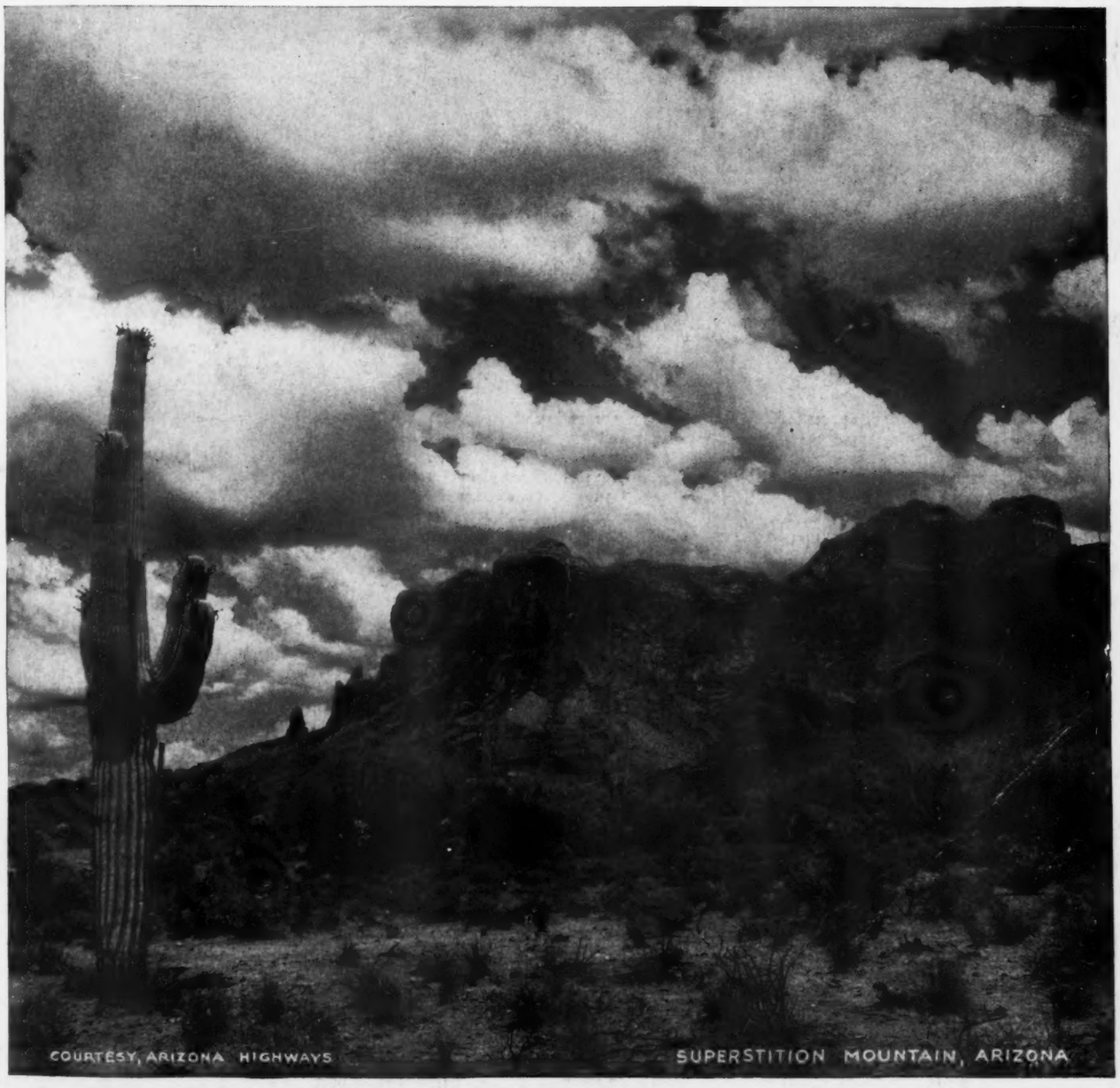

COURTESY, ARIZONA HIGHWAYS

SUPERSTITION MOUNTAIN, ARIZONA

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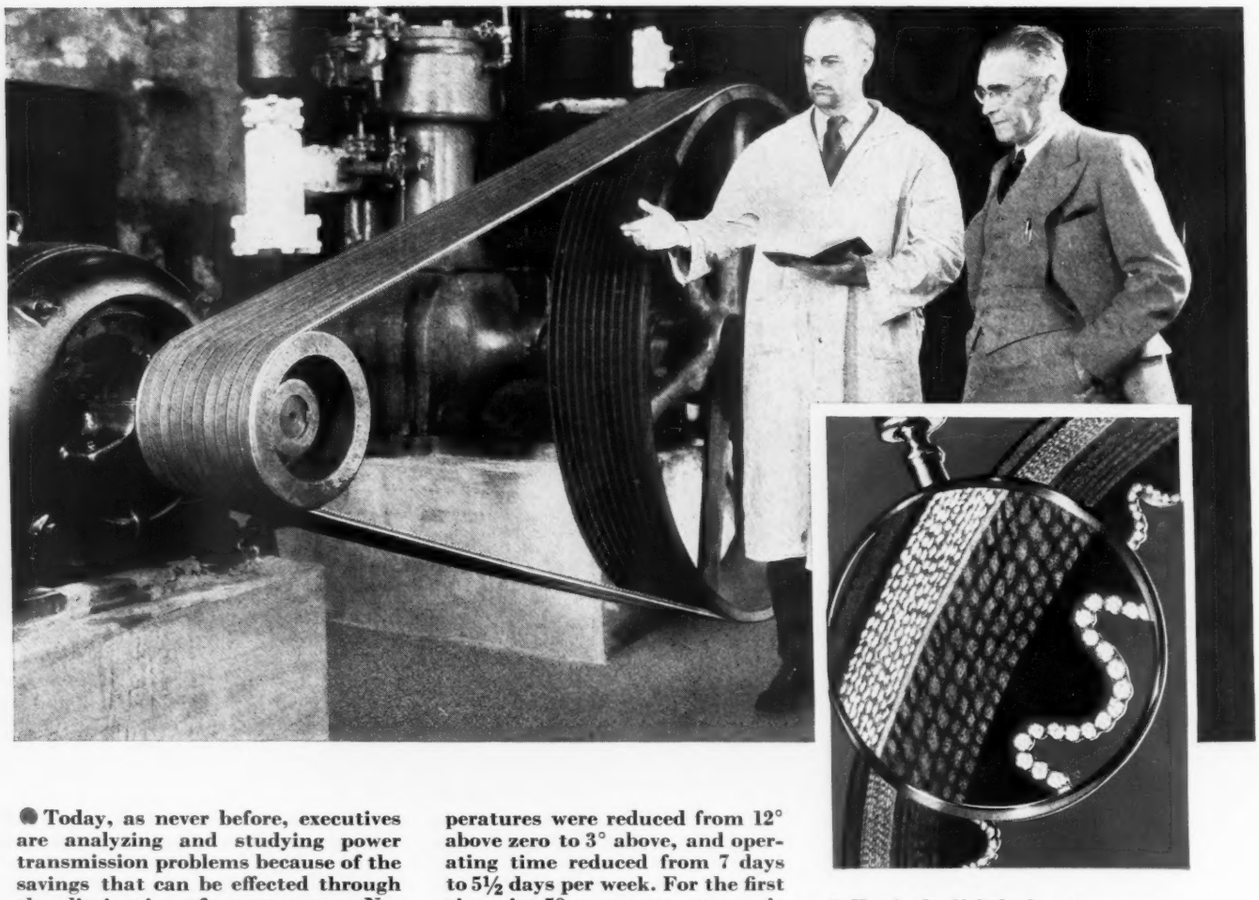

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Compressed Air Magazine

FEBRUARY, 1935

A Monthly Publication Devoted to the Many Fields of Endeavor in which Compressed Air Serves Useful Purposes

FOUNDED 1896

Volume 40

Number 2

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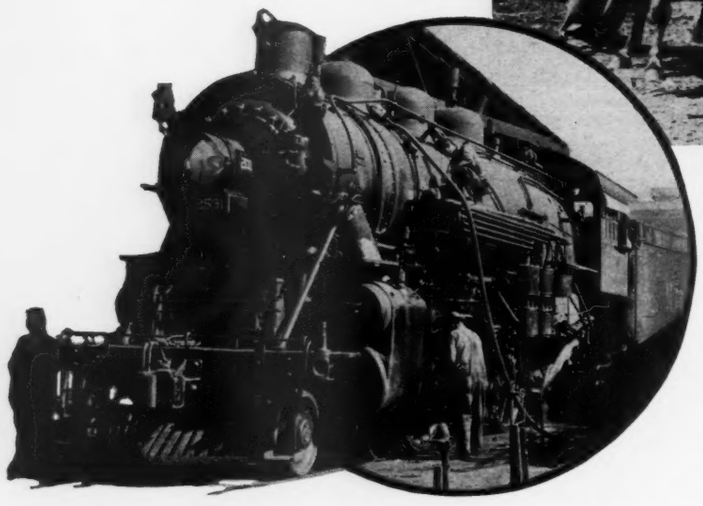
From Human Shoulders to Steel Rails

L. A. LUTHER



Transportation in Mexico is Undergoing a Gradual Evolution to Modern Methods

SOME of Mexico's most interesting folklore deals with transportation. There is, for instance, the well-authenticated legend concerning King Montezuma's fondness for seafood. Being one of the first absolute dictators in America, Cortez, the conqueror, found him living in truly regal pomp. Bringing fresh fish over some 300 miles of trail from Vera Cruz to Mexico City in those days appears almost impossible to us, considering that the latter lies more than 7,000 feet above the sea and was then accessible only by rugged passes; but a veritable legion of picked runners, posted at intervals along the trail and sprinting in short relays, are said to have delivered fish for Montezuma's table in the incredibly brief span of ten to twelve hours. Perhaps that ancient gourmet of the New World had a fondness for the pompano so much in favor today along the Mexican seaboard.

That established trade routes existed in Mexico long before the Aztecs created an empire there—probably before the beginning of the Christian Era—has been determined by sifting archaeological deposits left by successive civilizations, for to the archaeologist bits of pottery, seashell ornaments, and semiprecious stones and metalwork serve to reconstruct the story of a commerce carried on human shoulders. The area traversed extended from the Atlantic to the Pacific, and southward through the Maya cities of Yucatan. The picked bearers who brought commodities ranging from food to gold from various parts of the realm to the Aztec court at Mexico City represented the last word in transportation in the New World of the sixteenth century. But the benefits of trade were enjoyed by only a small percentage of the population; and influences of a growing civilization on contemporary groups a few hundred miles distant were more often effected by war parties than by social or commercial intercourse.

The Spanish *conquistadores* found the lack of roads a continual handicap; and their stone-paved highways such as the old Colonial Road, over which mule trains and carts brought tons of silver from the mines of Pachuca to the capital, remain to delight the tourist. The introduction of the horse and the ass from Spain revolutionized transport methods; and not a little of the present charm of Mexican byways is attributable to the survival of the oxcart and the burro. Perhaps much of the present appeal of Mexico lies in the comparative permanence of its ways and means of human existence. Before our ancestors had fairly founded New England and begun to build their frame houses and chapels, Mexico was raising well-nigh imperishable structures of mortar and stone; and thousands of residences, palaces, and cathedrals, in which the architectural influence of Old World cities is clearly defined, stand as monuments to this national propensity for building handsomely and well.

If distance has been the most potent factor in assuring the isolation and quaintness of widely diversified racial groups in Mexico, it has been equally a handicap in promoting social and economic homogeneity. Rail lines, it seems, have been the prime essential to development in all countries of the New World, as elsewhere, their extension almost invariably having transformed unprofitable frontier sections into national assets. Railway history in Mexico has been interwoven with the turbulent political fortunes of the country since the middle of the past century, for we find that the redoubtable general Santa Anna and the ill-starred Hapsburg emperor Maximilian granted franchises and evidenced much interest in the building of railroads. Instability of government made most railway projects abortive until the great patriot Juarez brought order out of chaos; and it is worth noting that he personally inaugurated service on the line between Mexico City and Puebla in 1869. Like his contemporary, Lincoln, he sensed the crucial

THE OLD VIES WITH THE NEW

Ancient methods of haulage are still used to a considerable extent in Mexico, although the advantages of the railroad are slowly but surely winning it increasing patronage. At the left, grain is being transferred from a bullock cart to a freight car at Tlajomulco, Jalisco, on the Mexican National. By way of contrast, the Mexico City train is shown below whistling as it enters the yards of picturesque Monterrey. On the opposite page are seen natives loading on to the backs of burros produce which has been borne across Lake Chapala by a miniature trading fleet. In the other picture, trainmen are grooming one of the Pacific-type locomotives which pull passenger trains on the Mexico City-Laredo run.

rôle to be played by railroads in binding together a vast and heterogeneous empire; and by fostering construction and by granting rights of way and generous subsidies he set a wholesome precedent and proved himself to be a true statesman.

The decade of the 1880's saw the peak of railroad building in the republic, whose mineral and other resources were then beginning to be appreciated. This epoch was contemporaneous with a period of rapid railway expansion in the United States; and, backed by great financial houses in New York and London, competition among the promoters supplied drama of an unusual sort. The objective in many instances was some forest area or mineral deposit; but lack of any coördinated plan sometimes resulted in running rails into sections not best adapted for the full development of the territory to be served and in the construction of paralleling lines. Just as the latter decades of the last century witnessed impetuous building by independent companies, so have the years since 1900 seen the gradual consolidation of those roads and, finally, their merging into the 8,500-mile system of the National Railways of Mexico. To the management of this system has fallen the task of gradually revamping and improving that vast network and of operating it in the best interests of the commonwealth.

The Mexican Railway Company, Ltd., operates 434 miles of trackage, its principal line lying between the capital and Vera Cruz. The Southern Pacific Company, after various interruptions during the revolutionary period, completed, in 1927, its 1,095-mile West Coast Route from Nogales, Ariz., to Guadalajara, in the State of Jalisco. Situated in the heart of Old Mexico, and rich in the traditions of colonial and ecclesiastical history, Guadalajara, with a

TROUBADOUR

This lad of ten or twelve years was snapped at a station where he entertained passengers while their train paused for a few moments.

population of 180,000, ranks as the second largest town in the republic. Varying widely in climate and geographic setting, each of the west-coast cities retains to a remarkable degree its individuality; and the West Coast Route, as the modern counterpart of the old El Camino Real, has begun to enjoy an increased measure of deserved recognition. The El Camino Real, which was built by the padres in sections representing a day's journey between their pioneer missions, closely parallels the line northward into California. The Sierra Madre, sister range of our Sierra Nevada and of the snowy Andes in South America, lends rugged charm to the scenery along this route and, incidentally, added considerably to the problems encountered in its construction.

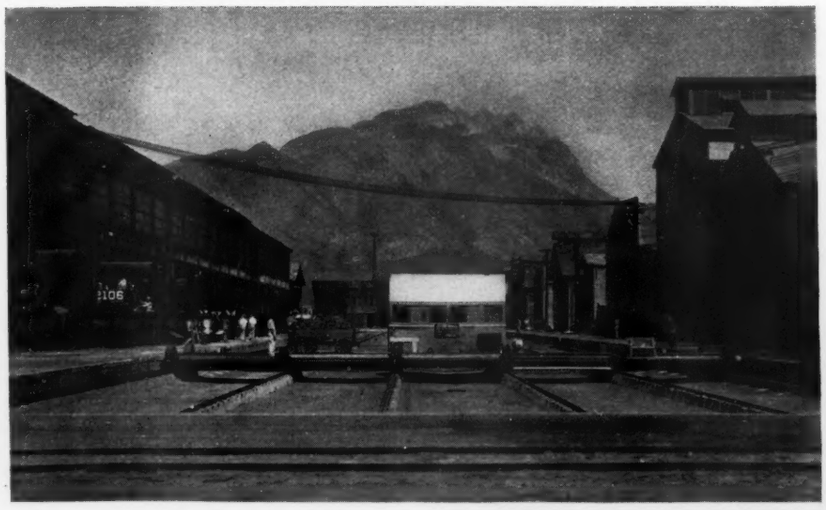
The National Railways maintain overnight service between Guadalajara and Mexico City; and a horde of visitors in 1934 found the West Coast Route a delightful short cut from California to the Mexican capital. Having accumulated a unique historic interest and distinctive architecture through more than four centuries of kalei-

ECHOES OF THE PAST

Everywhere in Mexico are reminders of former civilizations and cultures. Comparable in size with the pyramids of Egypt is the Pyramid of the Sun in Teotihuacan, holy city of the Toltecs near the Mexican capital. Almost identical with plows used in Egypt during biblical times is the implement with which the venerable farmer in the center picture tills the land near Tlajomulco. The stone sentry houses erected by the Spaniards (top) still guard the old Colonial Road over which fortunes in silver bullion from the mines of Pachuca were transported to Mexico City by mule train, ox cart, and wagon.

doscopic change, Mexico City is now a highly cosmopolitan metropolis in which the old and the new meet in fascinating contrast. Thousands "discovered" it for the first time last year; and three modern hotels are being constructed there to welcome guests who choose it as their headquarters in touring the surrounding country. A year-round climate not unlike that of the California Coast belies the tropical latitude of the great Mexican Plateau, making its towns equally appealing in midsummer or during the winter holidays. Remarkably preserved ruins such as those of the pyramids and temples of Teotihuacan, the holy city of the Toltecs, link the Mexican capital and its environs with the earliest civilization of the continent, a prehistoric era placed by some authorities at several centuries B.C. European invaders found on the site of the present city an Indian metropolis built on the vast lake that then filled the Mexican valley. Its thoroughfares were principally canals, its commerce was water borne, and sight-seers of that day were offered such unusual structures as huge pyramidal shrines and altars of sacrifice; 10-mile long, stone-faced levees; and aqueducts that supplied water drawn from a source near Chapultepec Castle.

The principal ports of entry over the tracks of the Mexican National are El Paso, Laredo, and Brownsville; and the line between the capital and brisk and thriving Monterrey—famous for its mountain setting and its beer—combines excellent travel facilities with one of the most scenic routes in the republic. Both freight and passenger rates in Mexico are surprisingly low, freight tariffs—on the basis of current exchange—often being but 25 to 30 per cent of those obtaining in the United States for comparable service, while first-class 1-way passenger fare is eight centavos, or approximately 2.2 cents per mile. To foster travel and trade by maintaining these rates while steadily improving the roadway and equipment is the exacting



WHERE THE EYES FEAST

Monterrey has a truly beautiful setting, as these pictures attest. Below is shown a vista across the city towards Saddle Mountain, with the Mexican National tracks in the foreground. Even the shops of the railroad afford unusually attractive views (left).

task confronting the National Railways. Operating methods conform pretty generally to American standards, the system being made up of twelve divisions which are staffed and run in the conventional manner. The executive offices are located in Mexico City, and M. Cabrera is executive president and N. Procel vice-president of operation.

Oil-burning locomotives are employed except on two divisions—Pacific type 4-6-2 engines, totaling 426,000 pounds inclusive of loaded tender, being generally used in passenger service. Though no experiments have been made to date with internal-combustion power plants nor with ultra-light trains, this newest type of equipment is being followed with lively interest. Heavy repairs on locomotives and cars are made in a large modern shop at Aguas Calientes and in smaller ones at Nonoalco and Monterrey. These can produce all parts required for maintenance exclusive of steel castings. The average run for locomotives in freight service is 180 miles, and for passenger engines it is as high as 1,000 miles, a typical run being from Mexico City to Laredo and back to Monterrey.

A broad program of modernization of shop equipment is underway. Typical of the economies effected or planned are those concerning the compressor plant at the Nonoalco shops. It has been estimated by the engineering department that by superseding three old steam-driven compressors with two 3,000-cfm. units of the synchronous-motor-driven type having automatic reduced-voltage control the power factor of the shops will be so improved that the investment of 135,000 pesos—representing fixed charges of 10,000 pesos per month—will be covered in less than two years by the combined savings in current cost and the elimination of the expense incident to purchasing and shipping oil from Tampico. The present power factor of the shops ranges around 0.55, while a factor of 0.85 is required for the minimum rate charged by the Mexican Power & Light Company, a corporation supplying power to industrial centers of the republic from three large hydro-electric developments, the largest being the 75,000-kw. plant at Necaxa in Puebla.

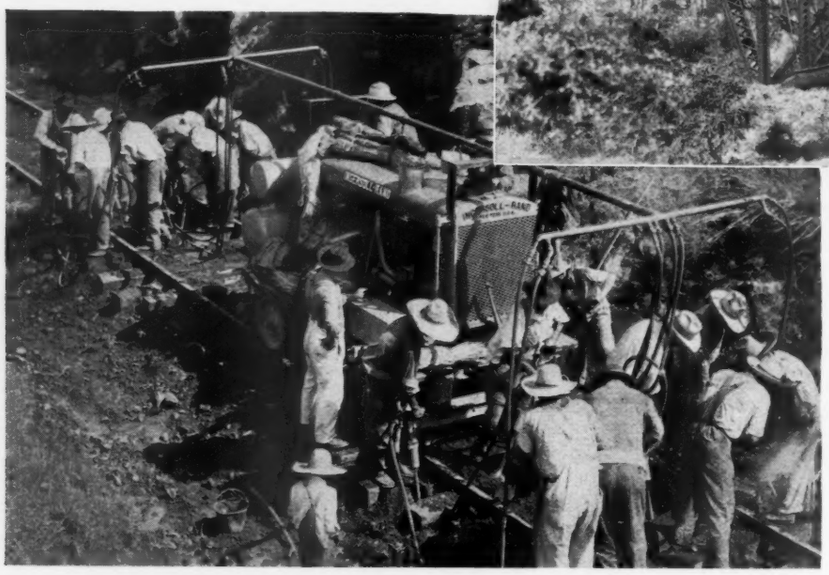
Thrift in the matter of roadway maintenance is evidenced in the universal use of creosoted timber for track ties and bridge material. The system is served by three creosoting plants located, respectively, at Acambaro, Durango, and Chihuahua. The Acambaro plant is the biggest and most modern, and is now creosoting daily from 5,000 to 6,000 ties which, for the most part, come from pine forests in the southern states of Mexico. The ties are thoroughly seasoned in extensive storage yards provided with trackage and handling equipment, and are treated by the Rueping process which combines cycles of pressure and vacuum. Automatic, electrically driven machines adz, brand, and bore the ties prior to stacking them in two 116-foot-long cylinders having a combined capacity of 1,400. Compressed air at a maximum pressure of 300 pounds gauge is supplied by an Ingersoll-Rand 12&5x10-inch XRE synchronous-motor-driven compressor.

The treatment is started by admitting air at 60 pounds pressure to the tanks for a 10-minute interval and then filling them with the preservative, a half-and-half mixture of creosote and impregnating oil. This is maintained at a temperature ranging from 176 to 194°F. by two 200-hp., 120-pound pressure boilers, and is fed into the cylinders by gravity—the air being permitted to escape as it is displaced by the fluid. With the tanks so loaded, the pressure is gradually increased throughout a 1-hour period to a maximum of 180 pounds, at which point it is held for one hour. The preservative retained by the wood averages 7 pounds per cubic foot. After the mixture is drained from the cylinders, any excess is withdrawn from the treated ties by subjecting them to a vacuum of 20 to 21 inches of mercury for 45 minutes. (The altitude at Acambaro is 6,000 feet.) Two Ingersoll-Rand ER-1 texrope-driven vacuum pumps, 22x9 and 18x7 inches in diameter, respectively, are provided for this purpose. Howe automatic weighing apparatus is employed in proportioning the creosoting compound and in checking the results of the impregnating process.

The mechanical equipment used on the system in roadway maintenance and bridge building work includes compressors, power shovels, and other motor-driven machines, as well as track cars for general inspection and for the transportation of the working gangs. At present, company forces have in hand the production and placing of 10,000,000 tons of coarse rock in connection with the construction of jetties on the Panuco

FOR COMFORT AND SAFETY

Railroad structures are well built and carefully maintained. At the right is the steel arch bridge across the Rio Chico on the Durango-Asenaderos line of the Mexican National system. Mechanical equipment plays a prominent part in the maintenance of tracks, structures, and rolling stock. Below is illustrated a tie-tamper crew at work on a section of the Guadalajara-Manzanillo branch. A 250-cfm., 2-stage, air-cooled compressor is supplying air for the operation of sixteen Mt3 tie tampers.



River, a navigable stream flowing into the busy Harbor of Tampico, the heart of Mexico's rapidly reviving oil industry. Pieces of limestone ranging in weight from 7 to 14 tons, with finer material which serves as fill, are being excavated at the rate of 500 tons per day in a quarry at El Abra on the San Luis Potosi to Tampico line. Twenty-foot holes on 20-foot centers are being drilled downward at an angle of 60° from the horizontal in the 320-foot-long and 160-foot-high face of the quarry with S49 "Jackhamers." Air is furnished by a 600-cfm. POC-2 oil-engine-driven, 2-stage compressor, and drill steel is reconditioned with a No. 26 oil furnace and a No. 34 sharpener. An EU "Utility" air hoist is employed in shifting cars.

Analyses were made last year of the economies and superior results obtained by the use of pneumatic tie tampers in surfacing track—a 250-cfm., 2-stage compressor, provided with self-propelled track mounting, being utilized to operate sixteen tools in connection with a track renovation program on the Guadalajara to Manzanillo line.

Careful management has enabled the National Railways to realize in striking fashion on the recent marked upturn in domestic and foreign traffic—gross earnings of 9,071,146 pesos for August, 1934, contrasting sharply with 7,305,265 pesos gross for the same period in 1933, while the August, 1934, operating expenses showed an increase of but 239,358 pesos over those of August of the year preceding. The fact that the operating revenue from January to August inclusive amounted to three times that received during the same period in 1933 augurs well for a further upturn in the business curve.

But additional improvements in the existing lines and in the operating methods are not the only items on the program scheduled by the management of the system. The southern elbow of Mexico, which forms some 20 per cent of the coast line of the gulf and the eastern extremity of which marks a gateway to the Caribbean, has progressed slowly since the days of the buccaneers, who found it an ideal base from which to make forays on coastwise and transatlantic shipping because it offered abundant food, a mild climate, and numerous sheltering harbors. Successively ravaged by pirates and *conquistadores*, its towns have been more or less content during a century of comparative calm to maintain the *status quo* and to dream on in tropic peace.

Lying in that section of the country is the State of Yucatan, which is fairly well served by lines of rail. Even so, however, its exploitation has been carried on in a more or less desultory fashion from harbors and rivers, and, together with the neighboring states of Tabasco, Campeche, and parts of Vera Cruz and Territorio Quintana Roo —representing a region richly endowed with forests, oil lands, and alluvial soil—is, figuratively speaking, an enchanted land that awaits the magic touch of through railroads to enfranchise it in this twentieth century world of Commerce.

Colonel Lindbergh first charted this Spanish Main from the air in 1928, and the Pan American Airways now provide a welcome short cut between the Mexican Capital and the principal cities of Central and South America, with much supplemental service locally by independent lines. Passengers on the Pan American trimotored planes catch glimpses of ruined cities built in the golden age of the Mayas as they take the air trail southward across a patchwork of jungle, river, and volcanic peak; and they will doubtless soon be watching with lively interest the gradual advance of lines of shining rails southward from some point on the Tehuantepec transisthmian route, probably from Santa Lucrecia in Vera Cruz.

This important project has been carefully studied for many years, but was held in abeyance because of the difficulty and the expense of construction in the alternately rugged and swampy region traversed by the right of way. Air surveys have facilitated the making of estimates: and, if present plans mature, 1935 will see the work underway. Tentative schedules call for the building of some 440 miles in a 5-year period, with a southern connection to the Peninsular Railway serving the State of Campeche.

While the farmlands in this area, if fully developed, could no doubt supply the nation with the necessary foodstuffs, and while its oil, mineral, and lumber reserves would give a tremendous impetus to industry, the commercial aspects of the enterprise are, perhaps, secondary to the political and social aspects, in that the undertaking is recognized to be a crucial step in the unifying of the nation and in its cultural advancement.

Dredging the Shannon River

CELEBRATED in folklore and song, and famed for its scenery and fishing, the River Shannon has had more than its fair share of publicity for a stream of its modest size. From source to mouth its bowed course measures only 240 miles, yet it is Ireland's largest and principal waterway. At various intervals it broadens out into shimmering lakes, giving the effect of crystals strung upon a silvery strand. These, together with a succession of canals, make the Shannon an important commercial transportation artery. The largest of the lakes, or lochs, is Loch Derg, some 40 miles upstream from where the river debouches into the broad estuary by which it enters the Atlantic. Loch Derg is 23 miles long. Just below its outlet, in County Clare, is the picturesque city of Killaloe, which has been the scene of extensive river-channel improvements during the past three years.

The changes were occasioned because more water had to be drawn from the loch to supply the head necessary to operate generating turbines in a government power house a few miles downstream from the city. This power-development scheme was put through by the Electricity Supply Board of the Irish Free State during the years 1925 to 1929, and the same body has carried out the river-deepening program. Prior to the construction of the power plant, a masonry weir at Killaloe sufficed to control the water level of Loch Derg, and adequately met the needs of the navigation canal system. As a part of the power-development plan, a new weir was built about three miles downstream from Killaloe. This served to raise the river surface in this 3-mile stretch to the level of the loch, and from it a portion of the flow was diverted into a headrace canal extending eight miles downstream to the power house. At the time, the demand for electricity was low and the required head at the turbines could be obtained with the facilities at hand. As the consumption of power grew from year to year, however, it became harder to draw sufficient water into the canal, particularly during low-flow stages of the river, and it was decided to deepen the channel to increase the supply.

At Killaloe the Shannon is about 515 feet wide and, prior to the work just mentioned, had a maximum depth of 11 feet 9 inches at high-water level. The deepening program consisted of lowering the channel on the side towards Killaloe, and affected a section of the river bed some 4,090 feet long and 197 feet wide. The bottom of the channel is now 18 feet below high water.

The operations called for the excavating of the river bed to a maximum depth of about 9½ feet—the total quantity of the material to be removed amounting to approximately 146,000 cubic yards. All the bottom material was soft enough to be dredged except 13,100 cubic yards of rock. This occurred in two locations, each about 3,600 square yards in area, and was composed of red sandstone. In addition to the excavation in the river bed itself, it was necessary to remove a section of the old weir about 230 feet long.

Work was started in 1932 on the weir and on the dredging of a number of high areas on the river bed. For these operations there was employed the maintenance equipment regularly used by the Electric Supply Board, including a dipper dredge consisting of a Ruston-Bucyrus 32-B excavator mounted on a steel pontoon. It was fitted with an extra long dipper arm which permitted it to dig 13 feet below the surface of the water. During 1932, some 35,900 cubic yards of material, amounting to 54,755 tons, was removed. The efficiency of the method thus having been satis-

DRILLING DETAILS

To the left and right are close views of the drill towers aboard the pontoon. The picture above shows rods marking the position of the drill holes, with the blasting crew on the pontoon beyond them.

VIEWS OF THE OPERATIONS

The left-hand picture shows a part of the strongly built weir after it had been disrupted by blasting. On the right are seen the drilling and blasting pontoons. The structure on the drill pontoon housed two 450-cfm. compressors and complete equipment for reconditioning drill steels. The blasters, on their smaller craft, followed close behind the drillers.

factorily demonstrated, it was decided to continue it. Accordingly, a second excavator in the form of a diesel-engined Ruston-Bucyrus 43-B was ordered. This machine had a dipper arm long enough to enable it to reach the full distance of 18 feet to which the channel was to be carried. After the delivery of this second unit in August, 1932, both dredges were employed, and they accounted for the removal of 72,000 cubic yards of material during the year. The work was completed in 1934 with a 37-B excavator replacing the 43-B.

A 58x25-foot steel pontoon was equipped for breaking up the rock. On it were housed two 450-cfm., electrically driven compressors of the Ingersoll-Rand type and a blacksmith shop containing a Leyner sharpener. Four Ingersoll-Rand N-75 drifter drills, mounted on towers, were installed on one side of the pontoon, the base of each tower being fitted with small wheels to permit moving the rig forward or aft along the pontoon edge.

No spuds were used on the pontoons, and positions were maintained by means of mooring lines, two forward and two aft, which were attached to anchors in the river or to suitable structures on the bank. About mid-length of each line was a return block, and between this and the pontoon the line was double. One end was made fast to the pontoon, while the other ran to a hand winch. By manipulating the lines, it was easy to shift the pontoon as desired. As each mooring line was 600 feet long, a wide latitude of movement was allowed before it became necessary to change the anchorages.

Six 40-ton barges were employed for the disposal of the spoil. These were towed to a deep area of the loch, about two miles away, and there dumped. Work was carried on 121 hours a week under normal conditions, and the zone of operations was illuminated at night by means of lights aboard the craft and floodlights on the near bank of the stream.

At the outset of the project, the removal of the old weir constituted a job of some magnitude. It had been built up between two parallel lines of sheet piling 5 feet 4 inches apart. The lower portion consisted of hand-placed rubble which was faced with hammer-dressed limestone blocks fitted together to assure close jointing. From the crest the face sloped downstream, the toe being carried outside the sheet-piling line until it met the river bed. The upstream side of the weir outside the piling was backed up with puddled material. A good many of the stones on the crest measured 6x3x1½ feet, and those in the face averaged about half that size. This necessitated breaking them up before they could be handled by the excavators. A diver was sent down to drill an initial set of holes to permit blasting an opening in the structure. After working faces were thus obtained it was possible to insert dynamite charges in the joints between stones or to break them by plaster capping. Powder charges had to be kept small because of the proximity of houses along the river bank.

In drilling the bottom, holes were carried 12 inches below the channel invert line to assure the removal of the required amount of material. The rock was overlain by mud and silt, up to 3 feet deep, and presented a more or less uneven surface. The holes ranged in depth from 3 to 10 feet. The average drilling time was only fifteen to twenty minutes, but the over-all time per hole was increased by delays of an unavoidable nature such as shifting of the pontoons, waiting for one or more drills to finish holes to permit moving, etc. It was found that the four drills could average about 200 holes in 22 hours. Poles, extending above the water surface, were placed in each hole after it was drilled. The blasting crew on a timber pontoon followed up the drillers and loaded the holes through tubes inserted in them. Firing was done electrically. Because of the nearness of shore structures, only one hole was shot at a time.

After the crews had become familiar with the work, the operations proceeded smoothly and with few difficulties. Some trouble was experienced at first in attaining proper positions with the pontoons. There also was a tendency on the part of the dredge runners to dig too deeply. After they had become accustomed to the problems, however, they were able to excavate to within 4 inches of the desired level. Time, too, was spent in determining how closely drill holes should be spaced and how heavily they should be loaded to shatter the rock sufficiently for easy handling.

The work was directed by the Civil Engineering Department of the Electricity Supply Board, and was carried out with local labor.

DREDGING

One of three pontoon-mounted excavators employed. This unit was capable of dredging 13 feet below the water's surface. Two other machines, with longer dipper arms, were later used for the deeper work.

THROUGH THE PORTAL
Looking out of the north end of a tunnel that is a part of the completed section of the Skyline Drive in Shenandoah National Park, Virginia.

Courtesy, U. S. Bureau of Public Roads

A 450-Mile *Pleasure-Only* Highway

C. H. VIVIAN

SINCE land transportation began, roads have been built primarily for utilitarian purposes. They have been designed to aid mankind in waging war, in colonizing new lands, in getting to and from his home and the various places where he has business, and in distributing foodstuffs, clothes, building materials, machinery, and the manifold other articles of commerce for which he has constant need. With the coming of the automobile, highways began to afford people pleasure, but only incidentally to their real reasons for existing. Here and there short stretches have been dedicated solely to the furtherance of human enjoyment, but such roads have been confined principally to park areas in urban localities. We may, accordingly, consider as somewhat unusual the idea of fashioning a 450-mile road over mountainous terrain for the express purpose of encouraging people to enjoy themselves amid pleasant and healthful surroundings. Yet, this is precisely what is being done in the case of the projected Shenandoah-Great Smoky Mountains National Parks Highway.

This road will start at the southern boundary of Shenandoah National Park in Virginia and follow an elevated course close to the crest of one of the Appalachian ridges, entering the Great Smoky Mountains National Park at its southern gateway in North Carolina. It will purposely miss all towns of any size, but will skirt Lynchburg, Roanoke, Asheville, and several lesser communities. It will not be the shortest route between the two national parks, nor the easiest to negotiate with respect to grade, hence will have little appeal to commercial traffic. For that matter, all but pleasure traffic possibly will be barred from it, although no regulation to that effect has yet been formulated.

For convenience in presenting the general facts concerning it, the undertaking is called a road, but it will be more than that. The National Park Service, which is cooperating with the U. S. Bureau of Public Roads in directing the work, and which has in hand the architectural phases of the project, refers to it as a parkway. This designation arises from the fact that control will be exerted not only over the right of way but also over a flanking zone 1,000 feet wide. Ordinarily, the highway will run through the center of this strip, but where the topography or scenic features make a different arrangement desirable, the greater portion of the parkway, or all of it, will lie to one side of the road line.

Parkways, as distinguished from mere highways, are a new development and have been confined so far almost exclusively to urban areas. The foremost parkway system now in existence is in Westchester County, New York, and was described in these pages in September, 1932. With the abutting land under its jurisdiction, the Government, in the present case, will be able to eliminate all undesirable features from the roadside. There will be no billboards, and such filling stations or refreshment stands as are duly authorized will be confined to specific sites and will be of approved types of architecture. Drivers will be able to enjoy the scenery without the necessity of keeping an alert watch for cars backing out of garages, crossing traffic, or coming into it from side roads.

In addition to the continuous parkway, there will be set aside at selected points larger areas for the recreation of the motoring public. These will be equipped with suitable facilities for picnickers. At other sites, which will be chosen largely because of their scenic interest, inns will be provided for the accommodation of guests for overnight or longer periods. These, as well as all other commercial ventures, will be privately operated under concessions, as is the general practice in national parks.

Inasmuch as the northern terminus of the parkway will be within from three to eight hours' driving time from such populous centers as Washington, Baltimore, Philadelphia, and New York, it is expected that it will be visited by large numbers of motorists each summer. Throughout most of its course it will not drop below 2,500 feet in altitude and will, therefore, offer almost certain relief from heat waves.

Extensive though it is, it is possible that

this parkway will eventually become but a link in a continuous route from the Canadian border to the southern limit of the Appalachian range. President Roosevelt is credited with having advanced the suggestion of thus enlarging the scheme. With a view to doing this, the National Park Service has already entered upon preliminary studies of a section in the Green Mountains of Vermont in order that additional construction work might be started if and when it is deemed advisable.

The idea of the Shenandoah-Great Smoky Mountains National Parks Highway apparently had its inception in connection with the roadbuilding program which is now underway in Shenandoah National Park. This road, of which more details will be given later, is designated the Skyline Drive by virtue of the fact that it will traverse the upper reaches of the Blue Ridge range throughout the 100-mile length of the park. It was only natural that the idea of extending this highway southward should present itself. When a proposal to this effect was laid before Government officials in Washington, it reached receptive minds because it was a public-works project that would provide employment for idle men. Accordingly, it was incorporated in the program of the Public Works Administration and more or less became a favored enterprise of the administrator of that organization. Sec. Harold L. Ickes of the Department of the Interior. Mr. Ickes has taken a leading part in all preliminary arrangements pertaining to the undertaking and has devoted considerable personal attention to it.

It is estimated that the completed parkway will cost $16,000,000 or more. In order to get the project started, the Public Works Administration had set up a fund of $6,000,000. Meanwhile, it having been determined that the project should be a joint undertaking of the Federal Government and the states concerned, various elective officials and influential citizens of Virginia, North Carolina, and Tennessee had become interested in the proposal and reached an agreement as to the division of the work involved. The Government reserved the right to select the route, and the states consented to secure the rights of way and deed them to the Government. The states also bound themselves to place their engineering staffs at the disposal of the Government for the making of the surveys. The Government agreed to defray all construction costs.

Surveys and field studies have been in progress for more than a year, but thus far no contracts for actual building have been awarded. In certain parts of the region concerned, alternate routes were tentatively laid out, pending final determination. The State of Tennessee conducted a vig-

DOING THE HEAVY WORK

Rock lies at or close to the surface almost everywhere throughout the right of way of the new road that threads its course along the serrated crest of the Blue Ridge Mountains. Wagon drills are the chief reliance of the contractors in breaking the thousands of tons of material that must be moved in its construction. These pictures show a modern drill of this type at work on the 10-mile contract held by Waugh Brothers. Portable compressors are now employed well-nigh universally on roadbuilding jobs. One of the new 2-stage, air-cooled class that has come into widespread use is illustrated below.

Photos U. S. Bureau of Public Roads

THE WINDING TRAIL

Section of the new high-level road in Shenandoah National Park, showing the Lee Highway in the valley and descending to Sperryville, Va.

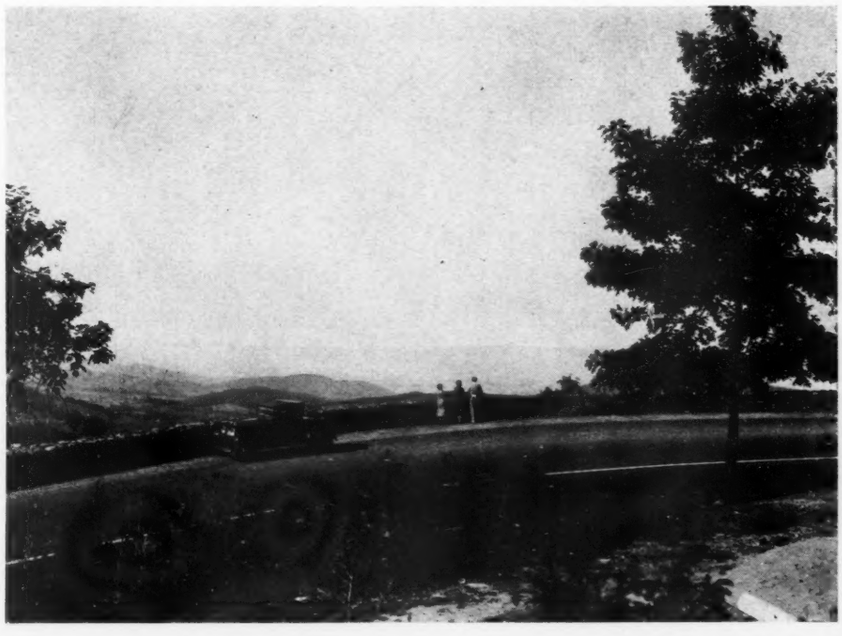
orous campaign for a road that would lead into the Great Smoky Mountains National Park within its borders and follow the upper levels of the Great Smokies. North Carolina contended with equal insistence that the right of way should traverse the Blue Ridge, Mount Mitchell, and Craggy Dome, which lie east of Asheville, and proceed thence along the Mount Pisgah range to the park entrance.

A board, consisting of three members named by Secretary Ickes, conducted hearings and decided in favor of Tennessee. Following an appeal from Gov. J. C. B. Ehringhaus of North Carolina, Secretary Ickes overruled the findings of this board on November 10, 1934. In selecting the North Carolina route, he brought out the point that Tennessee already has a well-established entrance to the park by way of Gatlinburg. He also recognized that Asheville, N. C., near which the parkway will pass, is dependent largely upon tourist travel for its existence. Although there is little choice between the two routes as regards scenery, the one in North Carolina was considered preferable because it offers the higher average altitude and therefore promises lower temperatures during the season of greatest travel. As now determined, the parkway will connect, near Cherokee, N. C., with the Smokemont-Gatlinburg highway which crosses the Smokies at more than 5,000 feet elevation. This road, which is one of rare scenic beauty, was described and illustrated in our September, 1934, issue.

With the settlement of the Tennessee-North Carolina controversy, the route became fixed save for a stretch of some 60 miles in the general vicinity of Natural Bridge, Va. The line laid out keeps to the ridge south of that picturesque point, but appeals have been made to shift it northward to lower ground so that it will touch or pass close to Natural Bridge. Final determination of this section is expected soon. Meanwhile, certain parts of the line which have been definitely selected are being surveyed by highway engineers and studied by architects of the National Park Service. With the completion of these preliminaries and of the securing of rights of way by the states, bids for the construction of the various divisions of the road will be asked for from private contractors.

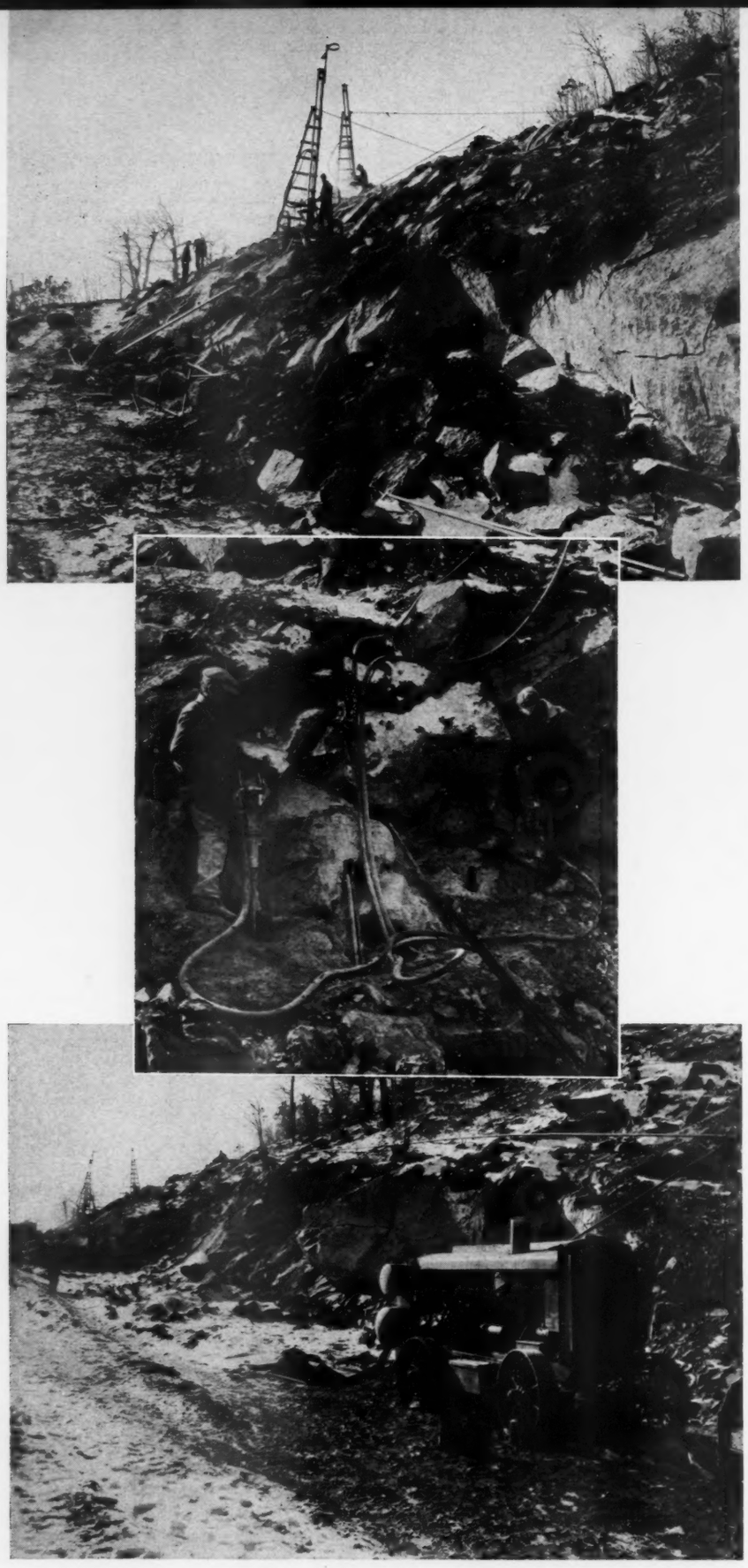
The matter of securing rights of way is necessarily proceeding somewhat slowly. Some opposition has been encountered from landowners, particularly from those of estates high up on the Blue Ridge that seek to have the route changed so as to miss their properties. The practice that is being followed is to obtain deeds to the 200-foot strip constituting the right of way proper, and to acquire scenic easements along the wider area or parkway. Besides these conveyances, Secretary Ickes, at the instance of President Roosevelt, stipulated that the states should secure options on chosen tracts with a view to adding them to the national parks area. Such sites are being passed upon by the National Park Service.

From a location standpoint, the road will be unique among long thoroughfares in that it will hold well to the tops of the mountain ranges to be traversed. The scenic effect, consequently, will be the reverse of the usual order, for motorists will view the mountains chiefly from above rather than from below. While the route can be loosely described as following the crest of the mountain chain, it is manifestly impossible literally to maintain such a course and keep grades within reasonable limits. The alignment will actually be controlled by the gaps interspersed among the various high points which punctuate the skyline. The road will touch virtually all these gaps, affording, in most instances, vistas of the lower elevations on either side. In intervening stretches, the line will skirt the peaks, keeping to the south and east



WHERE SCENERY BECKONS

Last autumn, after the first section of the Skyline Drive was opened, from 2,000 to 5,000 cars went over it every Sunday. Substantial but pleasing stone guard fences, of the kind shown here, contribute to the safety of the motorists.



"DRILL YE TERRIERS, DRILL!"

Three scenes in the drama of the mountain roadbuilder. Portable compressors designed to operate efficiently at high altitudes are drawn into position, and pipe is laid from them to advanced points where the drillers pierce the rock so that cylinders of dynamite may disrupt it. For heavy drilling are employed easily maneuvered wagon drills (top) that put down holes to depths of 40 feet, if need be. Hand-held "Jackhamers" (center) supplement them by drilling shallow holes wherever conditions call for them.

wherever the topography is favorable in order to obtain maximum sunlight and to avoid areas which are likely to retain snow for long periods.

The highway itself will be 20 feet wide, with a 5-foot shoulder on each side. It is likely that the driving surface will be paved with traffic-bound macadam, although specifications on this point have not yet been prepared. The generally ruling grade will be around 5 per cent, and, save for short sections, the maximum grade will be 6 per cent. Curves will be wide, and every effort will be expended to make the road both easy and safe to drive. There will be parking areas, termed overlooks, at scenic vantage points so that motorists may stop for leisurely sight-seeing without interfering with the free flow of traffic.

The architects of the National Park Service are concerned with the aesthetic features. Their aim is to mar the natural surroundings as little as possible while providing maximum accommodations for viewing the regions traversed. To make the road as inconspicuous as the topography will allow, the extent of vertical scar will be limited, and contractors will be required to construct retaining walls at the toes of fills which would otherwise extend beyond the limits set. Restrictions will also be placed on the scattering of materials by blasting, etc., beyond certain lines; trees will be protected against damage from blasting; native rock will be used for the masonry head walls of culverts; and quarry sites, from which to secure aggregates for surfacing, will be selected with a view to preventing permanent landscape scars.

While they are parks by common designation, the two regions which the parkway will connect are not as yet full-fledged national parks. The Great Smoky Mountains area is being administered by the National Park Service, but it cannot be developed for public use until 400,000 acres have been transferred to the Federal Government. Thus far 297,000 acres have been turned over to Uncle Sam by Tennessee and North Carolina. The Shenandoah National Park will attain official park status when 165,000 acres have been conveyed to the Federal Government. Virtually all this land has now been obtained by the State of Virginia for presentation.

As previously stated, the highway in Shenandoah National Park, which may justly be considered the forerunner of the interpark road, is well in hand. It is a large-scale operation in itself, and one that holds added interest because it is the prototype of the project which has been under discussion. For convenience of construction, the Skyline Drive has been divided into three parts, each ranging from 30 to 33 miles long. Combined, they run the full length of the park area, which extends from Front Royal on the north to near Waynesboro on the south. The middle division, lying between Thornton Gap on the north and Swift Run Gap on the south, was graded several years ago and was surfaced

MECHANIZATION

Not so many years ago, a roadbuilding job called for many horses. Today more horsepower is used, but it is concentrated in steel bodies. Gasoline and fuel oil have replaced hay on the contractors' supply lists. Here is shown the attack made on a stubborn point which gained the beguiling name of "Baby Face" when the rock happened to break in the outline of an infant's profile. The equipment illustrated has the work-performing capacity of scores of horses, yet it occupies little space and operates without confusion. This picture was taken on the contract of Sammons-Robertson Company.

last summer. The northern end, from Front Royal to Thornton Gap, is now underway. As the allotment from the fund for building roads and trails in national parks has been exhausted, work on the southern section will have to await the appropriation of an additional sum.

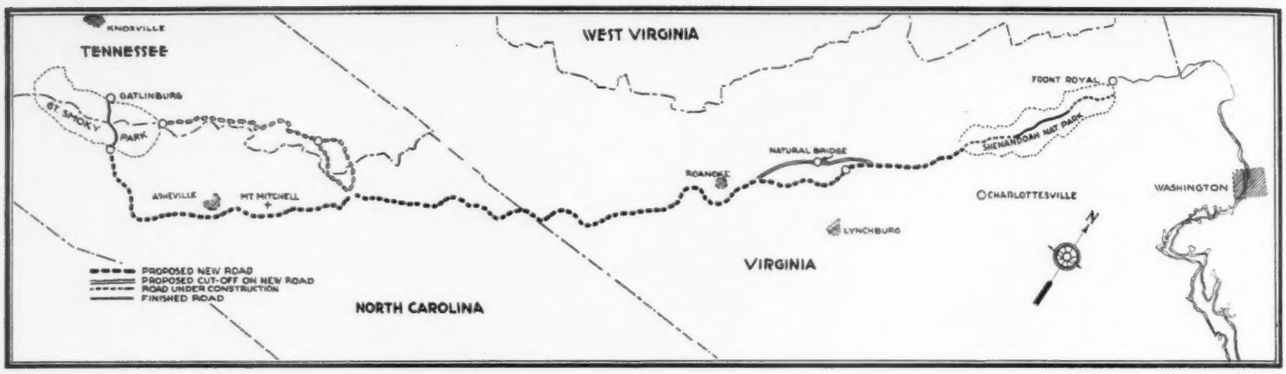
The completed stretch was opened to the public last September and immediately proved so popular with motorists that it is reasonable to assume that the longer inter-park route will be extensively utilized when it is ready for traffic. During the first three months of its use, the Shenandoah highway was visited by from 2,000 to 5,000 automobiles each Sunday and by an average of about 200 on week days. Having an altitude of from 3,000 to 3,600 feet, it affords spectacular views on both sides of the range. The panorama is an ever-changing one, while virtually at any point along the road a 1-minute walk will take one into forested uplands that seem remote from modern civilization. A connecting highway leads down into the valley of the Rapidan River where ex-president Herbert Hoover had his fishing camp when he occupied the White House.

Work on the Thornton Gap-Front Royal division is distributed among three contractors, all of whom made rapid progress during the past summer and autumn. Because of the unfavorable weather conditions, little is being done during the winter, but operations will be resumed early in the spring. In length, the three sections range from 9.7 to 10.5 miles, aggregating slightly more than 30 miles; and the total amount of the contracts is $1,095,732.50, or an average of about $36,500 per mile. These figures will give an idea of the heavy construction that is involved. Each contract calls for the clearing and grading of the road and the laying of a crushed-stone base for surfacing.

Except for short distances, where it follows the crest of the range or emerges in gaps between flanking peaks, the highway is of the sidehill type. As the slopes are generally so high that fills will not stand unretained, most of the grade is being cut back into the mountainside. As a result, more material has to be moved than would be the case if a considerable portion of the width were to rest on fill, but it makes for a safer and a more enduring road. As is to be expected, rock is at or close to the surface, so that construction necessitates the liberal use of drills and dynamite and the employment of heavy-duty, dependable equipment of all types.

The first section southward out of Front Royal is being built by Waugh Brothers of Culpeper, Va., under a $427,375 contract. It starts just outside the town limits, ascends the mountain, and runs southward on the western slope of the range, affording a magnificent vista of the valley of the south fork of the Shenandoah River and of the heavily wooded mountain chain beyond it. The grading involves the excavating of 413,000 cubic yards of unclassified material. To facilitate the work, a pioneer roadway was first put through on grade, most of the drilling being done with "Jackhamers." The widening to full size is now in progress and is being done with wagon drills, there being five Type D's on the job. Compressed air is furnished by four Ingersoll-Rand portable compressors: three 370 cfm., 2-stage, air-cooled, oil-engine-driven units and one 360-cfm. Type 20.

This stretch of the highway is characterized by the somewhat frequent occurrence of a fine-grained, copper-bearing rock which proves exceptionally hard to drill. It weighs up to 5,500 pounds per cubic



WHERE THE ROAD WILL RUN

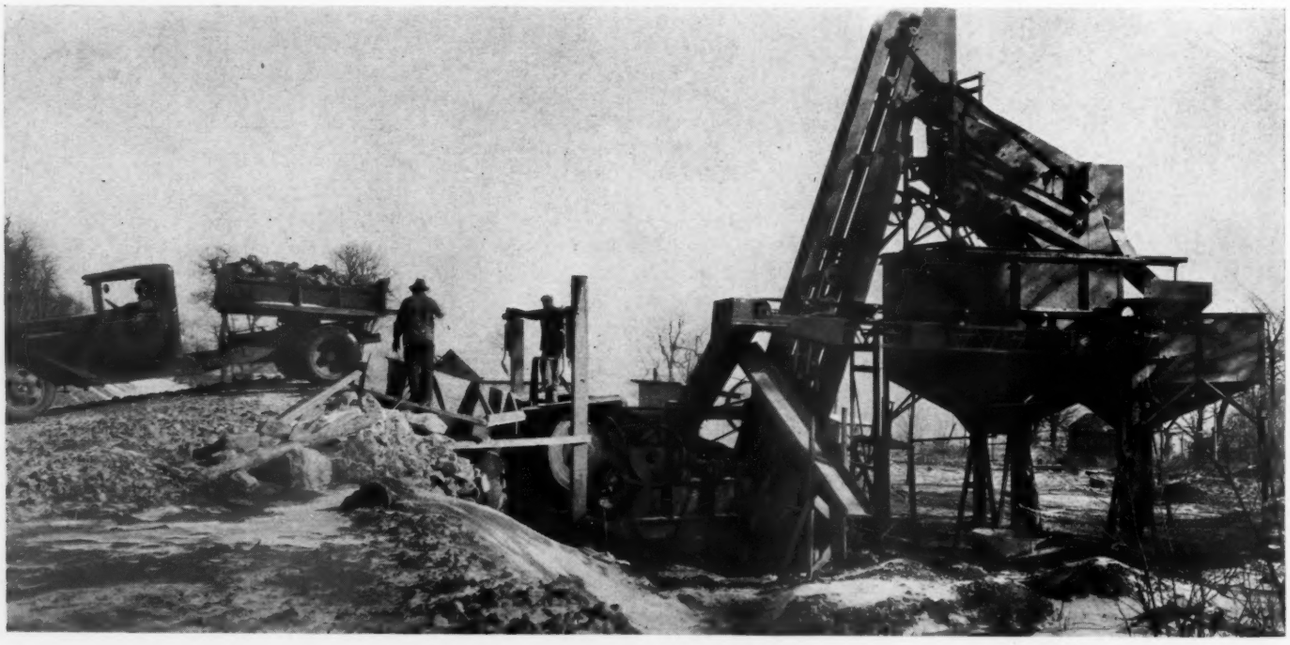
The heavy dotted line shows the course of the Shenandoah-Great Smoky Mountains National Parks Highway. In the vicinity of Natural Bridge it may be changed, as indicated by the double line. The hollow dots near the left edge mark the so-called Tennessee route which was overruled by Secretary Ickes.

yard and at times dulls twenty or more drill-steel bits per foot of hole. Spoil is loaded into LaPlant-Choate wagons by one Lima 101 gasoline shovel and two Lima 601 diesel's. Seven caterpillar tractors are employed for drawing wagons, operating bulldozers, etc. In addition to the grading, the contractors are crushing 36,000 tons of rock for surfacing. When activities ceased for the season shortly before Christmas, the contract was about 80 per cent completed. The work is in charge of M. R. Waugh, vice-president of the firm, and F. B. Daniels, superintendent.

Extending from the southern end of the section just described is the 10.5-mile contract in the hands of Sammons-Robertson Company, of Huntington, W. Va. It involves 338,000 cubic yards of excavating and the crushing of 36,500 tons of stone for surfacing, and was secured on a bid of $363,893. F. C. Sammons, president of the firm, has been on the job since its inception, with L. M. Henry serving as superintendent. F. W. Robertson, vice-president, has been engaged in directing some of the company's other work, but has made occasional visits to this contract. Construction is well along, and will be finished this spring.

Chief reliance has been placed on three Type D wagon drills in making blast holes, with X-59 and S-68 "Jackhamers" supplementing them. Compressed air is supplied by three Ingersoll-Rand 370-cfm., 2-stage, oil-engine-driven portables. Three Lorain 75-B shovels—two gas-engine and one diesel-engine driven—and a fleet of caterpillar tractors, Euclid wagons, and bulldozers constitute the equipment for moving and placing excavated materials.

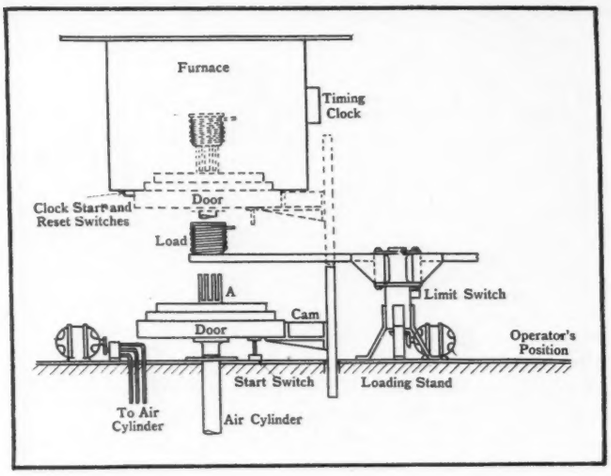
South of the Sammons-Robertson division of the Skyline Drive, Albert Brothers Contractors, Inc., of Salem, Va., are engaged on a 9.7-mile contract which they were awarded on a bid of $304,464.50. The firm consists of three brothers, Charles, Archie, and Lewis; and L. J. Messemer serves as superintendent and engineer on this job. The contract calls for the excavating of approximately 300,000 cubic yards. Included in the equipment with which this is being done are two Lorain shovels—one gasoline-engine driven and the other diesel-engine driven, five Euclid wagons, two Type 20 portable compressors, one Type D wagon drill, six "Jackhamers," and a Type 40 drill-steel sharpener.

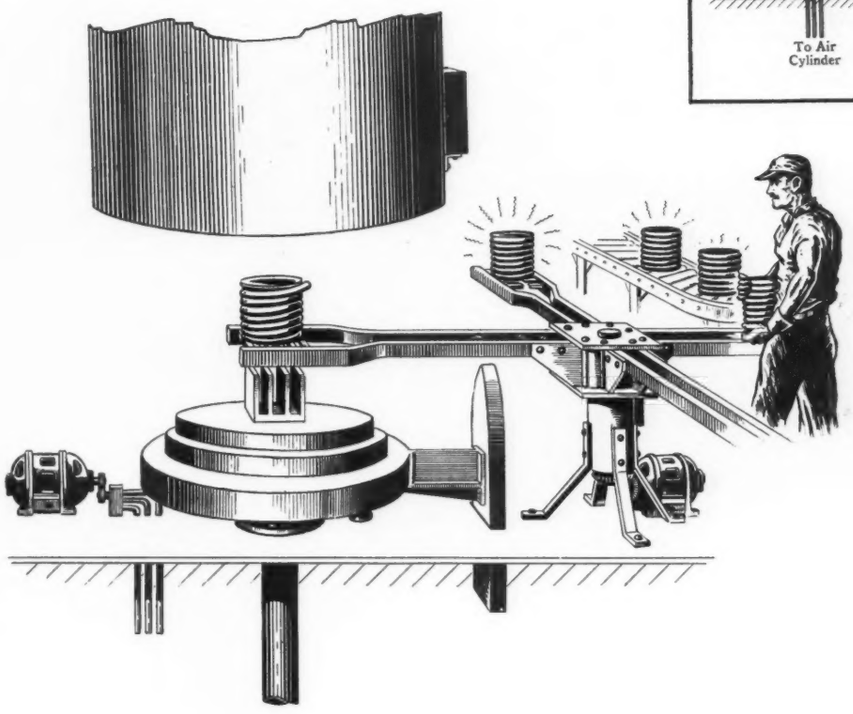


ACCESSORY OPERATIONS

Not all the roadbuilding work is done on the right of way. Approximately 90,000 tons of crushed stone is being supplied by three contractors to form the surfacing base of the 30-mile section of the Skyline Drive that is now under construction. This picture shows the crushing plant of Sammons-Robertson Company.

Novel Combination Furnace and Feeding Table





FURNACES that are suspended from ceilings are not according to our preconceived idea of such equipment; but one has been built with special loading facilities that is not only highly ingenious but also does what it was designed for—speed up the work of brazing copper coils to steel cans. This particular furnace is circular in form, and its gaping mouth is directed floorward. It is sealed by a door that is not an integral part of the structure but is mounted on a vertically disposed air cylinder in line with the furnace and serves, at the same time, as a platform on which the cans rest while they are undergoing treatment.

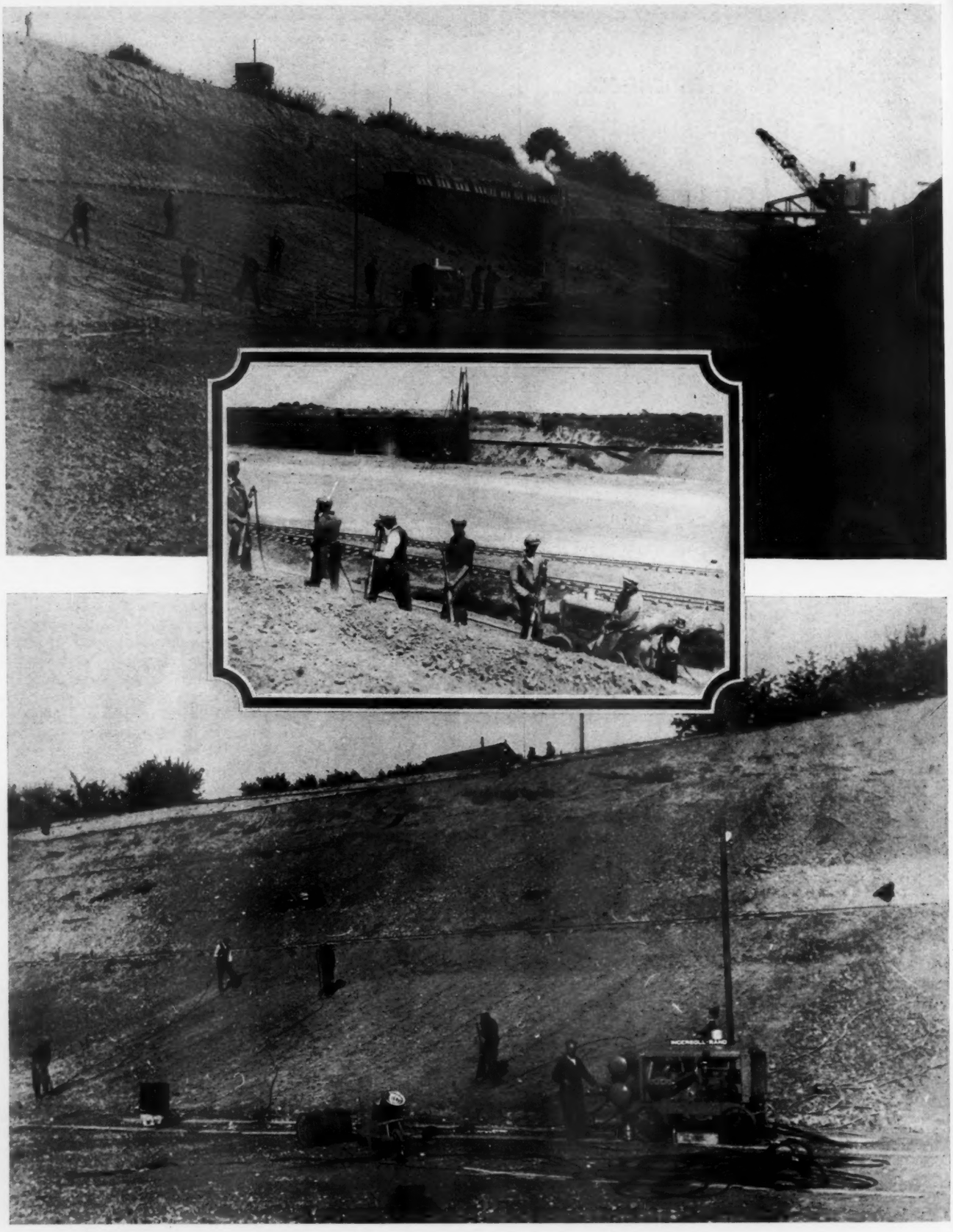
The feeding stand consists of a revolving center and of four sets of arms which are hinged separately to the former and provided with stops and springs so as to hold them at right angles to the stand when it is at rest. It moves clockwise by quarter turns and at a predetermined rate of speed that can be adjusted to suit requirements; and with each 90° revolution a can is spotted beneath the furnace, raised, brazed, and returned to the stand where it cools sufficiently before it reaches its starting point to be removed by the operator, who also attends to the loading. The two latter functions are the only ones that require hand labor, all the others are performed automatically by compressed-air and electrically operated equipment and instruments.

Let us assume that the attendant has just placed a can on the stationary arms in front of him and that the cylinder piston is at the bottom of its stroke. At that instant the furnace door comes in contact with an electric button, which closes the circuit on the stand and causes it to revolve. As the arms with their load reach a point almost over the circular door, an adjustable limit switch is tripped by the turntable and a chain of operations set in motion that ends in the opening of the valve which admits air to the cylinder. At once the door starts upward, again releasing the button and stopping the stand the moment it is in proper position with the can in line with the upright prongs of a nickel-chromium casting disposed centrally on top of the door. These prongs, which are indicated by "A" in the line drawing, pass through interlocked fingers on the arms and serve to transfer the can from the turntable to the door as it continues to rise. The arms themselves, as soon as their load has been taken from them, are spread sufficiently by a large cam on the door to give the latter uninterrupted passageway up or down, as the case may be.

When the piston has reached the end of its upward stroke, the furnace opening is closed. In effecting this seal, the door presses another button which starts an electric timer on the side of the oven that controls the brazing period. When the work is completed, this instrument automatically serves to make contacts that reverse the procedure—successively open the furnace, put the can back on the loading stand, and bring it around to the attendant who removes it and puts another one in its place, after which the cycle of operations is repeated. The timing device is reset by the door in its downward progress, and can be adjusted so as to meet the needs of the work in hand and to give the most satisfactory results.

For the particular work for which it was designed, a temperature of 1,700°F. is maintained in the furnace which, because of its inverted position, tends to retain the heat even when it is open. Aside from speeding up production, it assures a uniformly finished product and, together with its associate equipment, is capable of handling twenty cans in an hour. This is double the number that could be brazed before its installation. As can be readily appreciated, the furnace is not limited to the service for which it was primarily built, and, because of its efficiency and the ease with which it operates, will undoubtedly find many other industrial uses.

We are indebted to *The Electric Journal* and to J. J. Freese, of the Appliance Engineering Department of the Westinghouse Electric & Manufacturing Company, for the illustrations that accompany this article.



HOW THE WORK WAS DONE

Above are two general views of the lining work and an inset showing a crew of men compacting the layers of clay with pneumatic tampers. At various levels are railroad lines which served both for the removal of excavated materials and for the delivery of clay. The clay was applied in two or more layers, and a protective layer of gravel was placed on top of it. The upper picture shows a dragline engaged in excavating; and 9,000,000 cubic yards of material was removed.

Lining the Juliana Canal with Clay

L. H. Le POOLE

THE Juliana Canal, which was recently completed in South Limburg, Holland, after ten years of work, parallels the River Maas for approximately 18½ miles. Its purpose is to provide a transportation waterway along a stretch of the Maas where that stream falls 80 feet—a drop that was too great to permit its use by ships and that also prohibited any feasible plan of improvement in order to make it navigable. The man-made watercourse alongside links East Belgium and South Limburg on the one end with the northern part of the Netherlands on the other end. It is large enough to accommodate 2,000-ton vessels.

The Juliana Canal has a bottom width of 53 feet, a water-level width of 155 feet, and is 15 feet deep. Its construction involved the excavating of about 9,000,000 cubic yards of earth, most of which was dug out by power-driven draglines and loaded into railroad cars for disposal. The intake is at Borgharen, where the surface of the River Maas is raised by a dam to an elevation of 147 feet above sea level.

The canal is divided into three sections by four single-stage locks of the lift type: One at Limmel will be used only during high-water stages of the river; one at Born has a lift of 37 feet; another at Roosteren has a lift of 20 feet; and one at Maasbracht has a lift of 23 feet. At the latter point the canal again joins the river; and there the Maas is 67 feet above the level of the sea. Each lock has a usable length and width of 600 feet and 47 feet, respectively.

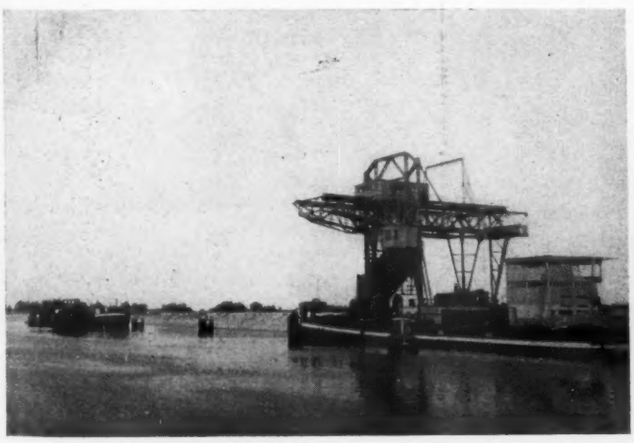
The chief purpose of the canal is to provide a means of transporting coal from the Dutch mines in South Limburg; and, so as to facilitate this traffic, two transferring docks are included in the scheme. One of these is at Stein and has a capacity of 1,500,000 tons a year. The other is at Buchten and has an annual capacity of 2,000,000 tons.

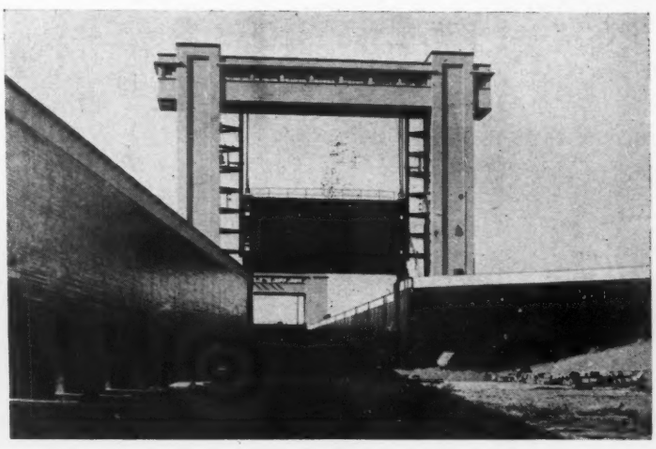
The undertaking bears the name of H. R. H. Princess Juliana, who broke the first ground at a ceremony held in 1925. By far the greater part of the canal has been constructed by the well-known Ltd. Contractors Business, formerly Mr. T. den Breejen van den Bout, Berg en Dal, Holland. By reason of the enterprise of that firm, the northern end of the canal, including the transferring dock at Buchten, was opened to navigation and the transportation of coal on May 7, 1934. As this is the lower section of the system, it was furnished water by pumping until the connecting link was completed.

Throughout the entire length of the canal its water level is above the ground-water level, the difference in some places amounting to as much as 47 feet. This circumstance, and the added fact that the earth in which the excavation was made is somewhat gravelly and therefore rather porous, necessitated that precautions be taken to prevent leakage. Accordingly, the bottom and sides of the canal were lined with clay to a thickness of up to 2 feet. In order to make sure that this lining would be watertight, it was placed in three layers of 8 inches each, and the layers were separately rammed with care. At those points where there is only a small difference between the water level and ground-water level, the lining was reduced to 1 foot in thickness and was placed in two 6-inch layers. To protect the clay lining against damage or erosion it was covered with 1 to 2 feet of gravel.

The ramming of the individual clay layers was started with hand labor, but it was not long before a change was made and pneumatic methods were introduced. Tools and compressors for this service were obtained by Ltd. Contractors Business from Ingersoll-Rand Company. As mobility was essential, portables were selected. Two Type 20 gasoline-driven units were put into service in 1927 and were utilized until the work was completed. By the time more compressed air was required oil-engine-driven machines were available, and two Type 40, two-stage, air-cooled portables were added to the equipment.

The clay for lining the canal was delivered by railroad over the same tracks which had been used to dispose of the excavated material. It was unloaded at several levels on the bottom and banks and then spread and tamped into position. A total of 820,000 cubic yards of clay was placed by the contractors mentioned.

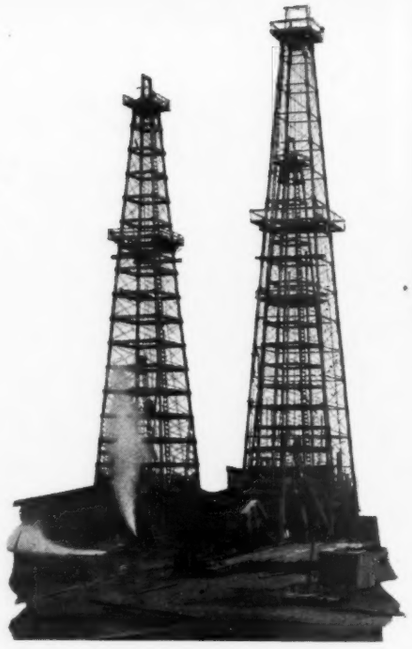




STRUCTURES ALONG CANAL ROUTE

The Juliana Canal will be used chiefly for the transportation of coal, and to facilitate that work transferring docks have been constructed at two points. The one shown at the left is at Buchten, and has an annual capacity of 2,000,000 tons. The difference in elevation at the two ends of the canal is 80 feet, requiring locks at several points. The one near Born, which has a lift of 37 feet, is illustrated. It has a usable area of 600x47 feet.

Locating Oil Wells By Air Pressure



F. R. COZZENS.

IN oil-producing sections of Ohio and West Virginia, where sands are "spotty" and hard to trace, new wells are being located with remarkable accuracy by means of air pressure. When drilling first started in those fields some 40 years ago, operators were of the belief that all oil sands ran in parallel courses, following the same general direction. Fortunes were spent with only an occasional strike. Thousands of dry holes were dug in sections which seemed to be sure-fire hits. But the old-time theory held its adherents for more than twenty years until compressed air proved its falsity.

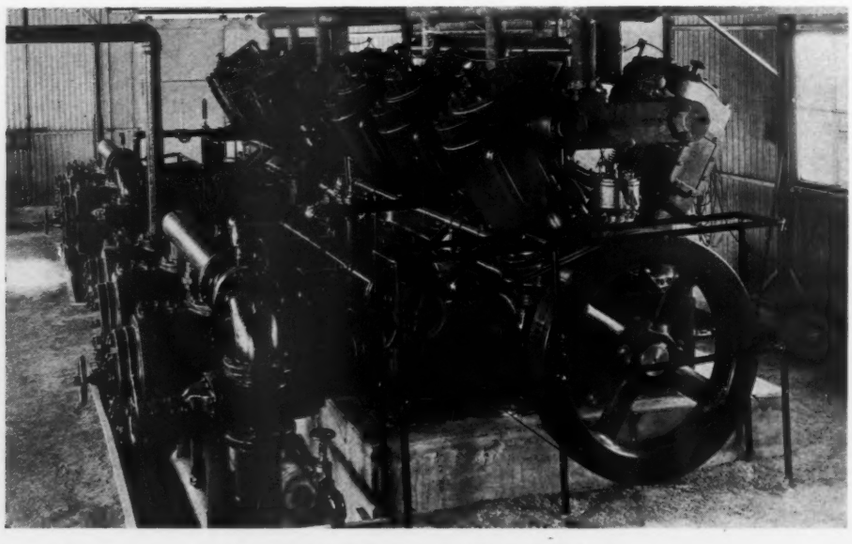
In 1915, air pressure was first applied in a general way for the purpose of forcing crude oil through sands where natural rock-pressure was low, and operators soon noticed that some wells responded quickly while other wells, presumably in the same streak, remained dormant. When the air pressure was shifted to the dormant wells, those that had received it first remained inactive. This discovery upset old traditions; but it proved the facts that oil sands were as crooked as streams on the earth's surface and that wells running along the same general lines with similar rock strata were not always in the same streak. Methods of locating wells were changed radically, and since then compressed air has played a very important part in redrilling those fields.

In locating wells, the modern operator now connects his compressor with a single well, known to be in the streak he wishes to trace. Pressure is applied, depending upon the depth of the well and the amount of the sand, and then results are awaited. Within a few days, or possibly a few weeks, certain wells in that immediate area will respond with an increased volume of gas, salt water, or oil, proving that the air has found its way through the sand to those points. Any locations upon a line between the active well and the one in which the air is forced will invariably strike that particular streak. Since air, like water, follows the line of least resistance, and pushes fluid sideways as well as forward, the site selected for a new well is usually a few feet off the direct course. Such a well is almost certain to be exceptionally good.

This method is quite simple where an oil streak follows a fairly straight line, but it seldom does so for any great distance. Bends and upheavals of rock strata must be reckoned with, and in such a case compressed air may perhaps perform its greatest service. Starting with the well where air pressure was first applied, there may be discovered another well responding some distance away, far to the right or left. The operator then gets out his log record of drilling operations in that field and usually finds one or more "edge wells" having only a very small quantity of pay sand. By comparing the amount of sand contained in the air well with that in the edge well, and by moving over a few feet inside the bend, he is sure to find the center of the streak. In this manner, a single streak of pay sand may be accurately traced for miles.

Air pressure also reveals hard and soft stratas of sand by the rapidity with which it creeps along a streak. It sometimes happens that a certain streak will "peter" out. Under such circumstances, the pressure on the air well greatly increases. On the other hand, a streak which is drained of oil will take enormous quantities of air.

These and numerous other reactions are carefully watched by the oil operator, and from them he gets a remarkable map of his territory. They enable him to locate producing wells without the old-time guesswork; and, as a result, many profitable oil streaks are being traced today in fields that were formerly abandoned.



MODERN OIL-FIELD COMPRESSORS

Natural gas is commonly available in oil-producing regions and offers the most satisfactory and economical fuel for driving machinery. Of late years rapid advances have been made in the development of direct-connected, gas-engine-driven compressors. Two machines of the latest design are illustrated. Each consists of three compressing cylinders directly connected to six power cylinders which are arranged in pairs. These units require little floor space and have various operating advantages and economies. They are built in four sizes of from one to four compressing cylinders. Those shown are designated Type 6-XVG.

TYPICAL DEPOSITS REMOVED FROM PIPES.

Removing Incrustations in Pipes

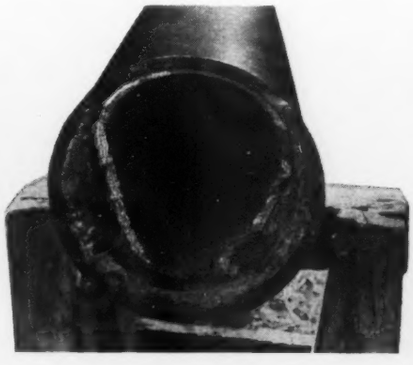
J. R. SHOTTON

AT THE termination of the Greco-Turkish War of 1922, nearly half a million refugees sought asylum in Athens, taxing the city's resources and bringing to a crisis the already existing need for more water. The latter problem was solved during the years 1926 to 1930 by the construction of the Marathon Dam by Ulen & Company, well-known engineers and contractors of New York City. This dam is unique in that it is the only completely marble-faced dam in the world. It holds additional interest because it is located almost exactly where the Athenians and Plataeans defeated the Persians at the Battle of Marathon in 490 B. C. As every highschool student knows, our modern Olympic Marathon race commemorates the feat of the Grecian runner Pheidippides who, having previously traveled two days and two nights to enlist the aid of the Spartans, hastened to Athens following the Greek victory to bear tidings to the populace. He literally ran his heart out, for on the outskirts of Athens he fell to the ground and died gasping the message: "Rejoice, we conquer!"

Marathon Dam is a concrete structure 935 feet long, 154 feet thick at the base, 15 feet thick at the top, and rising 177 feet above the bed of the river across which it is built. It contains 245,000 cubic yards of concrete and masonry, and is faced with a mosaic composed of Pentelican marble—the stone from which the Parthenon on the Acropolis was built. The dam impounds the waters of the Haradra and Varnava rivers, which formerly flowed into the Euboen Gulf. Owing to its historical significance, the site long has been a favored objective of tourists; and the dam, with its crystal clear lake behind it, has increased its popularity. Apart from making the dam a thing of beauty in itself, the Greek Government has provided additional artistic features, outstanding among which is a small temple at the foot of the structure. It is built of polished marble and is modeled after the Temple of Niki on the Acropolis. An excellent automobile highway winds through the pine-clad hills between the dam site and Athens.

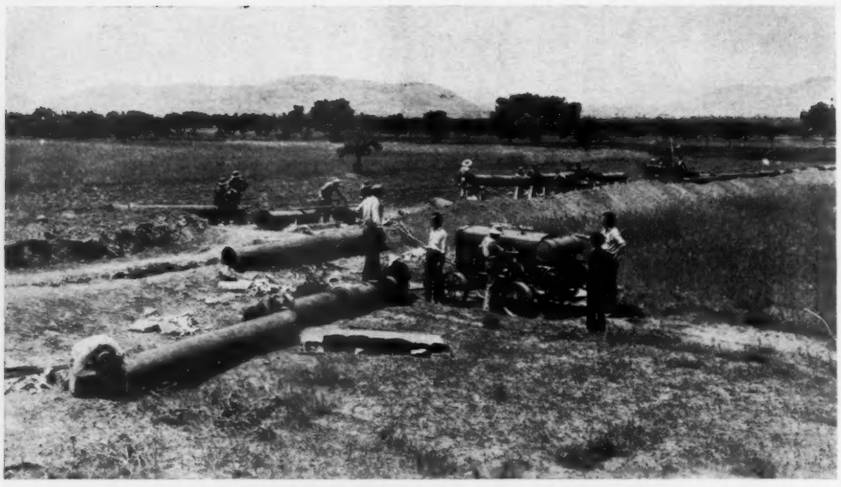
On its way to Athens, the water discharged from the dam passes through a tunnel, approximately 8.60 miles long, and flows into reservoirs on the Attic Plain near the city. This tunnel, called the Boyiati, pierces the Parnes Range. Of horseshoe shape, it is about 7.5 feet wide and 7.5 feet high, and is lined with precast concrete blocks. In driving it, the contractors maintained an average 24-hour advance of 36 feet and set a high record of more than 52 feet, including the placing of the lining.

Since the Marathon Dam was completed, the Athens Water Society has been engaged in linking this main distribution system with some of the older sources of supply. Among the latter is a group of collecting galleries and artesian wells at Kokkinara, near Kifissia, a suburb of Athens. For



REMOVING INCRUSTATIONS

On either side workmen are shown using paving breakers with long chisel-bit steels gouging the carbonate accumulation from pipe interiors. The picture above illustrates the extent of the 15-year deposit.



CLEANING CREW AT WORK

Using a portable compressor, driven by an oil engine, and two light-weight paving breakers the workmen were able to move from place to place readily, and the work of handling the heavy pipe was correspondingly reduced.

many years, water accumulating there has been led to the Hadrian Aqueduct, which was constructed by the Roman Emperor Hadrian between the years 115 and 130 A.D. That notable underground channel was built by the hand labor of many slaves from the tribes that had been subjugated by the Romans. It penetrates a limestone formation from 30 to 40 feet underground, and was lined with masonry throughout its length of 15.5 miles. Fingerprints of those who toiled there 1800 years ago are still discernible in the mortar.

Hadrian had served as archon or administrator of Athens under Emperor Trajan prior to his own ascendancy to the throne of the Roman Empire and had become very fond of the Greek metropolis. Accordingly, when he became supreme ruler, he took great pride in adding to the artistic and utilitarian structures of the city. In addition to the aqueduct, he constructed the Pantheon, several temples, a library, a gymnasium, and miscellaneous other edifices.

The aqueduct served effectually for centuries, but was finally allowed to fall into disuse. In 1840 it was rehabilitated and, until the building of the Marathon Dam, comprised the chief source of water supply for Athens. In 1918, a 16-inch iron pipe line was laid between the aqueduct and Kokkinara, a distance of 7,445 feet. When installed, it had a capacity of about 80 gallons a second. The hardness of the water is relatively high, being 298 parts per 1,000,000, of which 263 parts are carbonate. The normal flow through the pipe line varies between 10 and 24 gallons a second, or between 13 and 30 per cent of its carrying capacity. As the line has a hydraulic gradient of between 20 and 22 per 1,000, with an almost continuous and even slope, the practice of operating it at only partial capacity tended to induce a high velocity and considerable turbulence. The water was strongly aerated in consequence, and this aeration facilitated and accelerated the formation of a thick incrustation of extremely hard lime inside the pipe. This deposit accumulated until it was as much as 5 inches through in places—the carrying capacity of the pipe being greatly reduced as a result.

When the work of putting the Kokkinara system in first-class condition was started so that it might serve as a dependable supplemental source of water supply, it became evident that it would be necessary not only to remove the incrustation but also to take steps towards minimizing the deposition of lime in the future. The reconditioning method adopted was an unusual one. The whole line was dug up, and the pipe lifted out of the trench and taken apart. The incrustation was then removed with two Ingersoll-Rand L-54 paving breakers quipped with long chisel-bit steels. Compressed air was furnished by an Ingersoll-Rand oil-engine-driven portable compressor. Once the body of the deposit was cracked, the remainder came away easily, leaving the interior of the pipe in perfect condition. Many of the pieces were from 24 to 32 inches long—the wide variation in their shape being shown in accompanying illustrations.

Because of the low operating and maintenance costs of the equipment selected, and the rapidity with which the work could be carried on, the actual cost of removing the incrustation amounted to only about 3 cents per linear foot of pipe.

After the cleaning process, the pipes were coated outside and inside with tar and replaced. The total cost of the undertaking was $4,920, or about 66 cents per linear foot. As new pipe delivered at Piraeus costs $1.37 a foot, and as the laying of similar pipe on new work comes to 85 cents a foot, the plan to recondition the existing line rather than provide a new one resulted in a saving of more than $18,830.00.

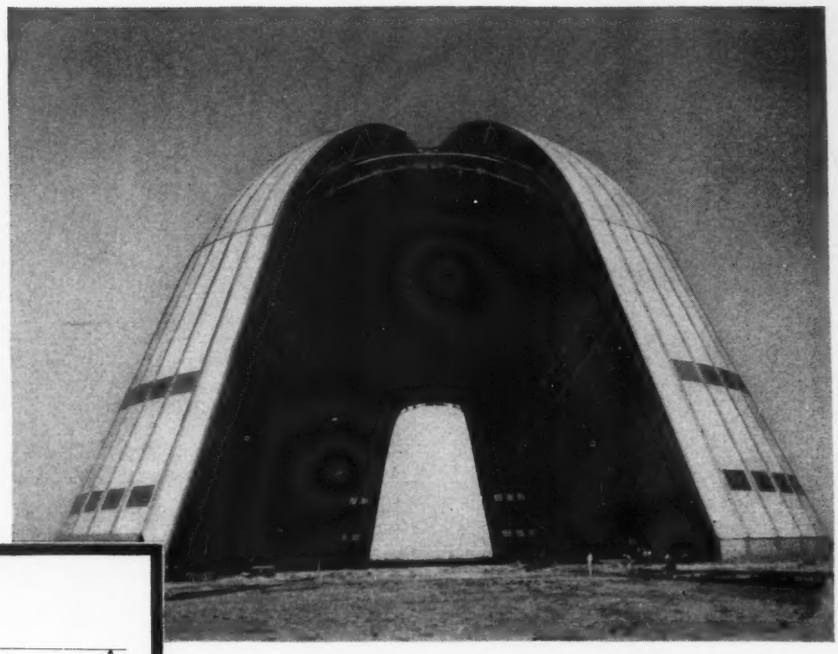
In order to reduce this incrustation to a minimum, it was decided to install a gate valve on the downstream end of the line so as to keep it filled with water at all times. This will serve to prevent aeration and will reduce turbulence to a low point. By suitably throttling this valve by means of a gauge on the upstream side the flow can be controlled as desired.

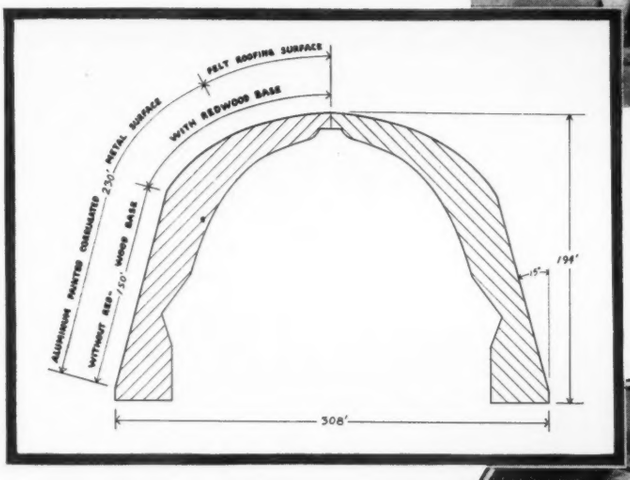
Thus the works of ancient and modern engineers and builders have been combined to form a dependable system that will insure a plentiful supply of water for many years to come to one of the world's most famous and most beautiful cities.

RECONDITIONING THE PIPE

The lime deposit came out of the pipe cleanly, leaving the walls smooth without the requirement of additional cleansing. The pipe sections were coated with tar inside and out and then replaced in the trench and covered.

Navy's New Home For Airships





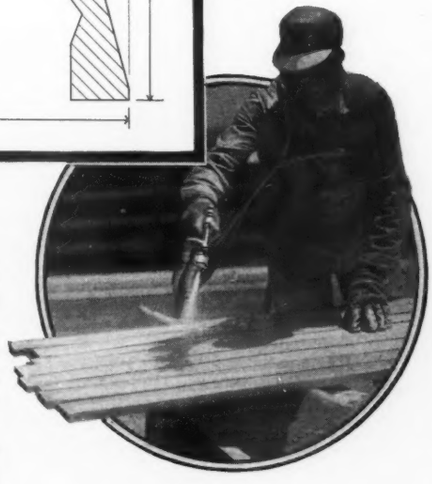
THE HANGAR AND ITS CONSTRUCTION

The hangar with the doors at the near end open and those at the far end partly ajar. The drawing to the left indicates where various types of sheathing were employed so as to avoid undue weight and to guard against moisture condensation in this huge structure whose length is equal to four ordinary city blocks and which is as high as a 16-story building.

SUNNYVALE, CALIF., is justly proud of the fine air base built there for the United States Navy. In fact, that station claims a goodly share of Californian superlatives because it is said to be the world's greatest in respect to buildings, equipment, living quarters, etc. All the experience gained in years of experimentation at Lakehurst, N. J., was drawn upon in creating this new base, the total cost of which is $5,000,000.00.

Outstanding among the buildings is the giant hangar that was primarily constructed to house the dirigible *Macon*, which recently foundered off the Pacific Coast while participating in maneuvers with the fleet. Reputedly the largest building anywhere without pillars or columns, it boasts more than 300,000 square feet of floor space—more, it is believed, than that in any other existing structure. It is 1,117 feet long, 308 feet wide, and 194 feet high.

In order to give the huge structure maximum resistance to the wind, its walls were built on a slope of 15° up to a height of 150 feet, at which point the curving roof begins. Air currents striking the sides are deflected harmlessly upward. Windows and skylights admit daylight to the interior.



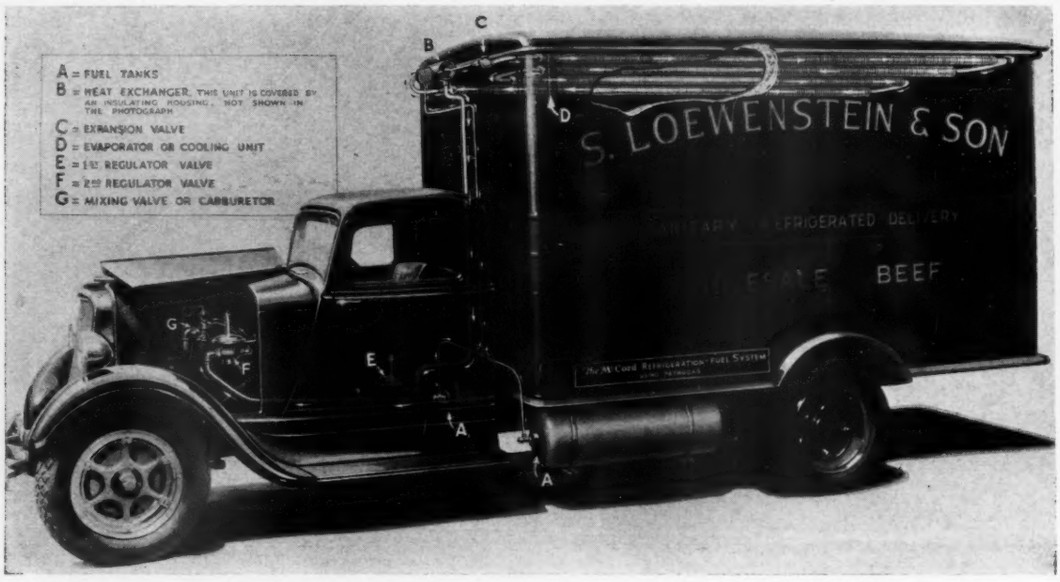
PROTECTING TIMBER

Spraying 1-inch redwood boards with aluminum paint prior to using them for sheathing.

In planning a building of this size and design, considerable attention has to be given to the problem of moisture condensation within. In the upper part, especially, condensation of warm air in direct contact with a noninsulating roof material would be extremely undesirable, and has to be guarded against. Siding and roofing have to be watertight and possess reasonable inherent strength without undue weight.

A 3-material covering was therefore decided upon for this hangar. From the ground on up to a height of 150 feet it is built of corrugated metal protected by a heavy coat of aluminum paint applied at the factory by spray guns. The succeeding course of 80 feet along the roof slope consists of similarly coated metal sheets overlying a 2-inch sheathing of California redwood. This layer of redwood gives a considerable degree of insulation without being excessively heavy, and is also protected with aluminum paint which was sprayed on at the construction site before the timber was put in place. The remaining roof section is of aluminum-coated redwood sheathing covered with a felt roofing material because that part of the hangar demands maximum protection against possible moisture condensation. As an additional precaution against warm air in the "loft" of this barnlike structure, a rectangular ventilating conduit has been installed beneath the ridge. This exhausts the warmest air and stimulates the flow of air from the ground level. Outside along the ridge is a wide catwalk for the use of workmen inspecting and repairing the vast roof.

Similar in appearance to the famous construction hangar at Akron, Ohio, the Sunnyvale hangar has a large orange-peel door at each end, thus permitting the dirigible to enter or to leave the structure through either doorway. From its very beginning, the Sunnyvale air base has been regarded as something more than a community project, and of its total tract of 1,750 acres but 750 were acquired by purchase, the remaining 1,000 having been presented to the Government by the cities and towns around San Francisco Bay.


A = FUEL TANKS
B = HEAT EXCHANGER, THIS UNIT IS COVERED BY AN INSULATING HOUSING, NOT SHOWN IN THE PHOTOGRAPH
C = EXPANSION VALVE
D = EVAPORATOR OR COOLING UNIT
E = 1ST REGULATOR VALVE
F = 2ND REGULATOR VALVE
G = MIXING VALVE OR CARBURETOR
S. LOEWENSTEIN & SON
BEEF

Same Gas Both Operates and Cools Truck

TRUCKS that utilize the same gas as a refrigerant for keeping their cargo compartments cold and as an engine fuel for propulsion have made their appearance. As the cost of the fuel for driving purposes compares favorably with that of gasoline, and as the cooling effect is secured incidentally, it is possible that this gas may come into wide employment in the transportation of perishables. The process as here described, was developed by the Shell Oil Company. The gas is one of the lighter distillates of petroleum, such as butane and propane, and is sold under the trade name Petrogas. The Shell Company has granted the McCord Radiator Manufacturing Company of Detroit, Mich., exclusive rights to manufacture and to sell the equipment involved, which is being produced under the name of McCord Refrigeration-Fuel System.

The operation of the system is explained in the accompanying illustration of a 2-ton truck that is employed by a firm of Detroit meat packers. The fuel, in liquid form, is carried under a pressure of 135 pounds to the square inch in twin cylinders, A, each of 23 gallons capacity and mounted under the truck, one on each side. From either of these reservoirs it is led upward to a heat exchanger, B, where the atmospheric heat of the liquid is removed. It then passes through an expansion valve, C, from which it issues into an evaporator or cooling unit, D, as a saturated gas at a pressure of approximately 5 pounds.

In its conversion from a liquid to a gas, it absorbs heat and thereby exerts a refrigerating effect. The evaporator is so proportioned that the gas leaves it in a dry state and then goes through the heat exchanger B, where it absorbs the atmospheric heat of the incoming liquid fuel, as previously mentioned. From the heat exchanger it passes through diaphragm regulating valves, E and F, where the pressure is reduced to atmospheric in two stages; next to a mixing valve or carburetor, G; and thence to the intake manifold of the engine.

The advantages of such a gas, in its dual *rôle* of fuel and refrigerant, are many. Considered as a fuel alone, it is economical because it is marketed at approximately the same price, on a performance basis, as regular gasoline and yet has properties that make it superior to even the highest-test gasoline. Further, its use results in the elimination of crankcase-lubricating-oil dilution, thus effecting savings in oil costs up to as much as 50 per cent. It has good antiknock qualities and forms virtually no carbon.

Being a perfectly dry and homogeneous gas when it enters the manifold, even distribution to each cylinder is assured, and the "hot spot" can be dispensed with, thereby permitting a less expanded charge of gas to be drawn into the cylinder than in the case of a gasoline-air mixture. As this fuel has a final boiling point of −40°F., and becomes a dry gas at higher temperatures, motor starting is never dependent upon a change in mixture and is, in fact, easier than with the highest-test gasoline.

Having an extremely high octane rating, it can be used advantageously in high-compression engines. Even with engines of ordinary compression, however, high efficiency is obtainable through its almost perfect combustion. This, in turn, is a decided factor in reducing maintenance costs, for it is now known that the wear on cylinder walls and on valves is caused less by abrasion than by chemical deterioration of the metal arising from incomplete fuel combustion.

The advantages of this kind of gas as a refrigerant are strikingly obvious, since refrigeration is in the nature of a by-product and is obtained at no cost whatever. Maintenance of the system is not expensive, because there are only a few valves to consider and no moving parts.

It should be noted in connection with the system that the degree of refrigeration varies in direct proportion to the amount of fuel consumed by the engine and is equivalent to 180 to 183 Btu's per pound of fuel. On runs where the engine is under full or partial load the greater part of the time, an excess of refrigeration may be produced, but this can be controlled thermostatically in a simple manner. On runs where many stops are made, where the doors of the refrigerator compartment are frequently opened and where the engine is idle for long periods, refrigeration is still adequate. The temperature of the compartment can be brought down to −25°F. when desired. From 10° to 20° above zero is a suitable range for ice cream, meat, fish, etc., and from 40° to 50° is considered best for fruits, vegetables, dairy products, beer, etc.

The system is easy to install, only a few changes in the conventional gasoline-operated engine are required, and the refrigerating equipment is not complex. The truck, of course, has to be well insulated, top, sides, and floor. The system is applicable wherever internal-combustion engines are used, and, therefore, is suitable for the operation and cooling of buses, yachts, etc.

RESEARCH IS PROGRESS

UNTIL a few years ago, scientific research was like one of our western "dry" rivers. Occasionally it suddenly rose to boom stage, then as quickly subsided. There was no sustained movement. Discoveries of importance were made by isolated individuals fired with the spark of genius, but the world at large failed to recognize the possibilities in their finds and, when their sponsors died, development ceased. Years later, some of these same things were rediscovered and are acclaimed as marvels of our age.

Specific instances in point were recently brought to light by P. G. Agnew, secretary of the American Standards Association. Radio, he informs us, is not really a recent scientific achievement, but merely the outgrowth of inventions made in past generations. In 1843, Joseph Henry, who later became the first secretary of the Smithsonian Institution in Washington, D. C., successfully transmitted electromagnetic waves a distance of 200 feet, and even passed them through the walls of buildings. Faraday and Maxwell also contributed important knowledge; and in 1888 Heinrich Hertz built in Germany what was really a radio sending apparatus. In 1889 Sir Oliver Lodge set up a radio receiving station, and in 1897 he patented "tuning coils" which were the forerunner of the radio dials we now use. In 1906 Fessenden actually broadcasted a program, and a year later he transmitted human voices across the Atlantic Ocean.

All of these things were accomplished without electron vacuum tubes which are now universally employed. These, in turn, were conceived long ago, Edison having worked on them prior to 1885. DeForest put the tubes into practical form in 1907, but no one seemed interested in them and so he let his patent lapse rather than pay a $25 renewal fee.

Popular interest in wireless was aroused by the unforgettable SOS of the *Titanic* in 1912. Broadcasting as we now know it started on Nov. 2, 1920, with the opening of Station KDKA in Pittsburgh—the presidential election returns being the first important news of the day to be sent out from there.

Today we see how vital it is to keep the current of scientific advancement flowing steadily. Hence, progressive organizations, both public and private, maintain research staffs to coördinate developments that have gone before and to use them as stepping stones to reach greater heights. The practical value of laboratories has been so well established that they no longer need to be defended.

SIMPLIFIED MEASUREMENTS

AS EVERYONE knows, Henry Ford is a nonconformist. He does not hesitate to step off the beaten path if he thinks his course will take him to his destination more quickly. Innovations are more or less the rule in his establishments. It is not surprising, then, to learn that a system of decimal dimensioning has been adopted by the Ford Motor Company in making most of the parts produced by it. Instead of being divided into eighths, sixteenths, thirty-seconds, and sixty-fourths, the Ford scales show fifths, tenths, and fiftieths. An article by Athel F. Denham, in *Automotive Industries*, points out that, except in the U. S. Ordnance Department, all engineering dimensioning in this country always has been based on common fractions. Through the adoption of decimals are obtained some of the advantages of the metric system without the objections commonly raised by us to that system.

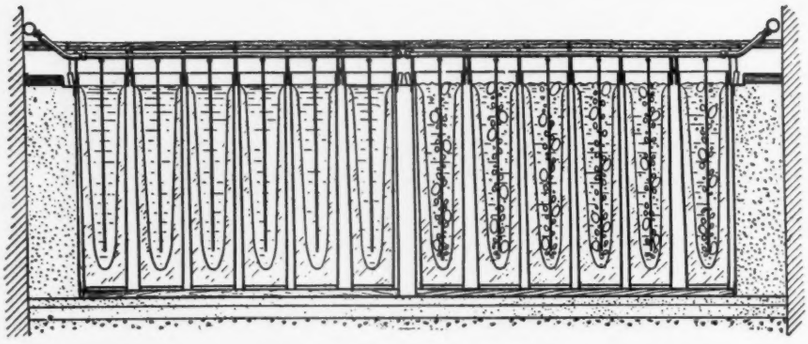
"To appreciate the value of the Ford system," the article states, "it is only necessary to note that when any of the common fractions in use today must be changed into decimals, the resulting decimal is of cumbersome length. For instance, a fraction such as seven sixty-fourths to be expressed correctly would have to be carried out to six decimal places (0.109375). When it becomes necessary to add long columns of common fractions, as must be done repeatedly both in making drawings and in checking the accuracy of parts made from them, the complications and chances for error are obviously multiplied in addition to the complications involved through requiring the use of conversion tables, etc."

FOR PLEASURE ONLY

OUT of the bounty of the Federal Government, the people of the mid-Atlantic states are to be given a new sort of playground. As described in an article in this issue, the Shenandoah and the Great Smoky Mountains national parks are to be joined by a 450-mile highway which will cling to the crest of the easternmost ridge of the Appalachian chain. In effect, it will be an elongated park, for a 1,000-foot strip of border land, with here and there a bulge to greater width, will be included.

In establishing the national-parks system, the Federal Government long ago acknowledged its obligation to place Nature's gifts at the disposal of the citizenry. However, Nature herself, by lavishing her most appealing charms on the West, complicated Uncle Sam's problem. Most of the national parks are beyond the reach of more than three-quarters of the population. Notable exceptions are the two areas just mentioned; and it is only fair that the Government should be extra liberal in making them easily accessible to the millions who must be content with them alone. Approximately 50,000,000 persons live east of the Allegheny Mountains, and probably more than half of them are well within a day's drive of this new parkway which will offer an escape from worldly cares and relief from heat waves.

NEW COMPRESSED-AIR AGITATING SYSTEM FOR ICE MAKING



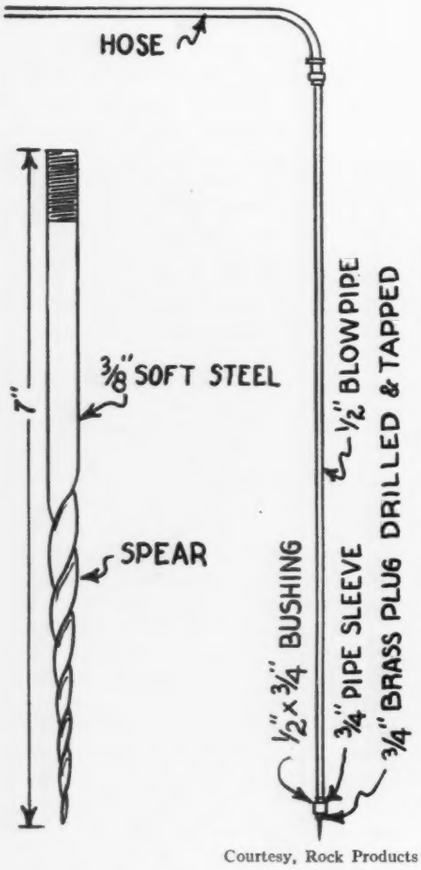
IN THE manufacture of ice, it is the practice to agitate the water in the cans so that the cakes may be clear. This is done with compressed air by means of tubing in the tank-room floor and by hose lengths inserted into the individual cans. This method has been improved upon, according to the Canadian Carbondale Company, of Toronto, which has made the following statements about what is known as the C-A System.

The principal difference between the old and the new methods is that, in the case of the latter, the compressed air is not admitted into all the cans in a tank at once, but is alternated—the water in half of the cans being charged while that in the other half remains quiescent. This goes on during the entire freezing period, and is effected automatically by a special motor-driven timing device that directs the flow of the air from side to side at predetermined intervals. For the average plant a 30-second interval has been found to give good results. When the change-over is made, the air in the main header, lateral, and tubes of the inactive half of the system is trapped, thus preventing the water from rising in the tubes. Agitation therefore starts the moment the air is turned on, and there is no need of clearing the line of water. It is claimed for this method that it produces clearer ice than those commonly applied, and that less time is required to form the cakes of ice.

The multiple tubes are each connected to their lateral by a flexible rubber tube, and this gives the former some freedom of movement and permits them to assume a vertical position in the cans even when the lateral is slightly tilted. This is of advantage, in that it assures satisfactory circulation of the air and, as a result, thorough agitation of the contained water. The tubes can be quickly detached in case of breakage or if any one or more of them have become frozen solid in the ice. Those still attached to the lateral can then be removed with it in the usual manner while the others can be freed at leisure by means of the thawing needle.

HELPFUL HINTS TO THE QUARRYMAN

IT'S the little things that count, for minutes spent in performing some trifling tasks may save much time and trouble in the end. That's the principle upon which the Cedar Bluff Quarry, Princeton, Ky., is run, and the operator finds it worth his while. He is using an Ingersoll-Rand X-71 wagon drill on a 32-foot face, and has devised some accessory equipment that other quarrymen might like to learn about. One is a blowpipe, and the other what he terms a spear.



Courtesy, Rock Products

It is the practice there to remove drill steel from the hole, no matter what its depth, at the end of the shift, and to plug the opening with cotton waste. Before drilling is begun the following morning the waste is withdrawn and the hole cleared of damp cuttings by the aid of the blowpipe. These simple operations do not take much time, and are said to be the means of preventing delays and, incidentally, expenditures.

The spear, to quote the quarryman, "has been worth over and over again the little trouble it took to make it." On occasions, he says, steels will break while at work; and when the bit end is less than 2 feet long it is next to impossible for the steam shovelers to find it in the rock pile after shooting. With the spear, however, its recovery can be effected quickly, except when the steel is very long or is stuck too tight.

Before the worker begins fishing, he blows the accumulated dust from the exposed face of the bit with the blowpipe. The spear, which is attached to a length of pipe, is then lowered and manipulated until the point finds the opening in the steel. Once inserted, he gives the pipe a turn with a wrench and taps the top of it with a heavy wooden block. So firmly does the steel generally become affixed to the spear that a good steady lift will bring the former to the surface. In fact, nine out of ten are retrieved in this way. Lengths of 2 feet and more are usually left in the hole for subsequent recovery.

COMPANY MAKES A BUSINESS OF CURING CONCRETE ROADS

A NEW JERSEY firm of contractors considers the curing of concrete roads an operation quite apart from their building, and not long ago, in constructing a 4½-mile cut-off for the State Highway Department, sublet that part of the job to a company that is specially equipped to do it. The Stedfast Rubber Company, of Boston, Mass., is in the business, and uses two different materials to effect curing—cocoa matting and white rubber sheeting. These come in rolls to facilitate application, and are carried by a truck as the work progresses. There are 40 feet of matting on a roll and 100 feet in the case of the rubber, which is considerably lighter in weight.

The matting is placed first on top of the green concrete after the latter has been thoroughly sprayed with water. Next the matting is saturated and protected with the rubber sheeting. This serves as an impervious blanket and prevents the evaporation of the water during the curing period, which ranges from 48 to 72 hours. At the end of that time two men roll up the coverings like rugs on wooden rods with the aid of handles that are inserted into the ends of the rods for that purpose; pile them on the truck; and transport them to the succeeding strip of freshly laid concrete, where the operations are repeated.

SHRINKING METAL WITH DRY ICE

WE have it on good authority that dry ice is finding increasing use in contracting metal parts for making what are termed shrink fits. Liquid air has been utilized for this purpose, but is not generally practicable. In speaking at a recent meeting of the American Society for Testing Materials, Mr. W. H. Swanger, of the National Bureau of Standards, gave the following interesting facts based on tests conducted by him. In his experiments he made use of three combinations of materials —a brass ring on a brass pin; a steel ring on a brass pin; and a steel ring on a steel pin. Each ring was 1 inch long and of 1 inch internal diameter, and the assembly was made when the diameter of the pin was about 0.0015 inch larger.

In making shrink fits by cooling the inner member with dry ice, it was determined that seizing does not occur until relative motion has taken place between the two contracting surfaces, and that the force necessary to continue the separation of the fitted parts is very much increased after seizing. For instance, in the case of the brass ring and pin, the initial slip did not occur until a load of 2,200 pounds had been applied; and a maximum of 4,370 pounds was required to continue slippage. For the steel ring on the brass pin the figures were, respectively, 5,400 pounds and 6,800 pounds. The steel ring did not slip on the steel pin until a load of 5,725 pounds had been exerted; and, as with the two other combinations, the load decreased immediately and then increased rapidly until a maximum of 19,000 pounds was attained. Failure of the brass ring to seize is attributed to particles of metallic lead in the alloy, while bits of brittle sulphide in the steel are partly responsible for its tendency to score the brass.

DEPTH BOMBS FOR BLASTING BRIDGE FOUNDATION

AN INGENIOUS method of excavating subaqueous rock was practiced in San Francisco Bay when bombs dislodged 60,000 cubic yards of material from the site of the south tower of the Golden Gate Bridge. This scheme was followed because it was evident that the conventional drilling procedure was impractical under the existing conditions. The site was 1,100 feet offshore, and was exposed to a tide that sometimes reached 6 knots. Work had to be commenced in 65 feet of water and carried to elevation −100.

Blast holes were made by successively dropping small bombs in the same spot. Each of these consisted of a 30-inch section of 2-inch pipe loaded with 3 pounds of 60 per cent dynamite backed up with cement mortar. The bomb, pointed at the bottom, was held in a chuck at the lower end of an 8-inch steel spud 30 feet long and weighing 5,100 pounds. Dropped through the water from the end of a derrick boom with that weight behind it the cylinder penetrated the serpentine rock on the sea floor to a depth of several inches. The explosive was fired 80 seconds after the fuse was lighted just prior to its release. Each charge made a hole from 18 to 24 inches deep and about 18 inches across. Twelve such bombs were normally used to penetrate 20 feet.

Into the hole thus made was dropped a large bomb of 8-inch pipe and loaded with from 100 to 350 pounds of 60 per cent dynamite. The penetration end of this pipe was cut to form four gores which were welded into a point. The space between the dynamite cartridges was filled with cement, and on top of the charge was poured about 18 inches of concrete. For a blast hole 20 feet deep the pipe was made 22 feet long, and it was driven into the excavation by a 2½-ton falling weight suspended from a cable. Blasting wires were coiled within the top of the pipe, and these were brought to the surface by a diver and connected with the battery after the bomb had been bottomed.

So as to make sure that the bombs would find their mark, they were lowered through 120 feet of 14-inch steel casing, operations being conducted from a barge moored with six anchor lines. This tube was drawn up sufficiently to escape damage just prior to firing. In order to locate holes, and to hold positions once obtained, a transit man was on duty 24 hours a day at a control station.

Spoil was excavated with 3- and 4½-cubic-yard clamshell buckets and loaded into a 500-cubic-yard dump scow for disposal in deep water. Although the operations were necessarily slow, they were in every way successful. The work was done by the Pacific Bridge Company.

TERRA COTTA ADDS COLOR AND BEAUTY TO ARCHITECTURE

WITH the vogue for bright colors everywhere, even in the factory, architects have again turned to terra cotta, that adaptable structural material that traces its history back to the ancients. As in the past, it is now widely used to decorate the exteriors and the interiors of public and private buildings; but where ornamented terra-cotta tiles and the like were once more or less fragile, those of today are durable and fast in color. These properties are attributable to modern methods of manufacture, as well as to the fact that the color is applied before instead of after firing, as was the case in the days gone.

Procedures as old as the industry itself go hand in hand with new ones in turning out a wide range of terra-cotta products of any desired shape and color. The work, in part, is specialized, calling for artists who draw and model the designs to be reproduced perhaps once or many times over to meet requirements. After the raw material or clay has taken form in plaster molds, which are patterned after the original designs, the section of a frieze, cornice, or whatever it may be, is removed and thoroughly dried before it is passed on to the spray room. There the face of each piece— that is, the side which will be exposed when in place, is coated with a ceramic mixture that is also the vehicle for the coloring matter. The mixture is applied with compressed air by means of spray guns. The work is now ready for the kiln, where the heat serves not only to fire it but also to bring out the color.

ADDING THE BRIGHT TOUCH

In the spray room of one of the several plants of the Atlantic Terra Cotta Company where the molded and dried clay forms are surfaced and colored in one operation with a ceramic mixture applied with air under pressure.

This and That

Sea Gull Golfers

Wombats, gophers, prairie dogs, and numerous other animals are known as great excavators. Now it seems that sea gulls are going in for the practice in a big way. According to the Bureau of Biological Survey, they are wreaking havoc with golfcourses along the Pacific Coast. Dub golfers are accessories before the fact, for it is the divots which they dig from the turf and later replace that the birds concentrate upon. Great flocks of them settle on the fairways, uncannily locate the loosened bits of sod, and pluck them out. One club at San Mateo estimates that it spends $1,000 a month repairing the damage done by the birds.

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A Credit to His Calling

A few weeks ago, prominent railroadmen gathered at a luncheon at the Union League Club in New York City to hear their praises sung by the American Museum of Safety. Some of them received medals awarded to the companies they represented as tokens of their leadership in safety. Some of the foremost industrialists and public men present commented and commended. A veritable Who's Who of railroading listened. But not all those in attendance belonged to the so-called "brass-collar" group. Among them was one from the ranks, and his name, like Abou ben Adhem's, led all the rest. He was Jerome Mauk, for 39 years an employee of the Union Pacific Railroad. He is a foreman, and no worker under him has ever suffered an injury. Who could have a better right to sit with the mighty?

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A Silver Mine in Hollywood

A Hollywood plumber who was running a profitable silver mine as a by-product of one of the movie studios, had his "claim" jumped by the picture people when they discovered what he was about. Writing in *Chemical & Metallurgical Engineering*, A. B. Lainge explains what happened. The drain pipe leading from a tank containing the "hypo" solution in which the film was developed frequently became clogged. On such occasions a plumber came, dug up the line leading from the studio, replaced it with new lengths, and left. Suspicion that all was not as it seemed was aroused by the fact that the plumber's bills were very small. Investigation revealed that the section of pipe adjacent to the building was so laid that the "hypo" solution would collect in it. This caused the silver removed from the film during the developing process to precipitate. As the quantity of this metal was determined to be considerable, it was judged that the plumber's side line must have been lucrative. At least it led the studio to take steps to recover the silver.

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A Master Railroader Retires

Word comes from Colorado that William R. Freeman has retired as president of the Denver & Salt Lake Railroad, the line which Dave Moffat built and which was recently incorporated, in part, in a new transcontinental system through the building of a connecting link with the Denver & Rio Grande Western. Because the line was a minor one, Mr Freeman's accomplishments were never widely heralded, yet he displayed something of the genius that brought fame to some of the nation's early railroad barons. When he took charge of the road as coreceiver, in 1917, it had $35 in cash and creditors enough to line its right of way. Within ten years he had transformed it into a paying business with $1,000,000 in its treasury. It emerged from receivership, and Mr. Freeman became its president. He did all this by being the supreme boss. The Moffat Road, as it is locally known, was a one-man concern.

Having been trained in every phase of railroading, Mr. Freeman could not be fooled, nor could he be fooled with. He had a telegrapher's set on his desk, and every message that went over the line came to his ears. He changed orders, or issued new ones, merely by opening the switch and tapping out the appropriate characters of the Morse code. Under his guidance the shops of the road became models of efficiency, with the most modern and most economical equipment. Engines were there reconditioned or rebuilt to stand the severe service of pulling trains across the Continental Divide. There, also, was devised and made a pneumatic mechanical hand with steel fingers for removing ice from high-altitude tracks in advance of the locomotive. While the Moffat Tunnel was being completed, Mr. Freeman went abroad to study railroad bores there, and upon his return he personally dictated the sort of ventilating system he wanted installed.

When Mr. Freeman took charge, bonds of the road were worth $4.85 per $100, and the common stock could hardly be given away. Yet the Rio Grande management paid $155 a share for that same stock to gain control of the line, and this happened during the depression. Having had faith in himself, Mr. Freeman had acquired much of the stock when it was going begging; and he left his desk and its telegraph instrument with a tidy fortune.

MINING MANIKINS

An exhibit at the exposition held in conjunction with the meeting of the Western Division of the American Mining Congress in San Francisco, Calif. It illustrates mining as it was practiced before modern rock drills and other mechanical equipment appeared on the scene. The display was sponsored by the Wells Fargo Bank & Union Trust Company of San Francisco.

Industrial Notes

A new grouting mixture, called Aquagel, has been made available by the California Talc Company, Los Angeles, Calif. It is said to permit the use of low-pressure air for its introduction and to retard the initial set from 72 to 120 hours.

The Coppus Engineering Corporation of Worcester, Mass., manufacturer of Annis air filters for internal-combustion engines and air compressors, has issued two new bulletins covering the entire air-filtration field. These may be had by writing to the company.

The Garlock Packing Company, Palmyra, N. Y., has added to its list of products an improved oil seal that is said effectually to retain oil and grease within bearings while excluding dust and dirt. It is being marketed under the name of Garlock Klozure.

Anyone using compressed air or gas will be interested in Bulletin 9212 recently published by Ingersoll-Rand Company, 11 Broadway, New York, N. Y., and descriptive of its various types of aftercoolers. It is well illustrated, and explains why aftercoolers are needed and how they work. A copy can be obtained free upon request.

To facilitate the handling of large panes of glass, a device is used in Germany that holds the individual sheets by suction. It consists of a long handle with a rubber vacuum cup at each end. These grip the pane tight when pressed against it and permit carrying it by the handle. To release the suction, air is allowed to flow into the cups by working a small lever with which each is provided.

In the basement of the Department of Commerce Building, Washington, D. C., there has been set up lately a camera that is 31 feet long, 20 feet wide, and weighs 14 tons. It was developed by the U. S. Coast and Geodetic Survey to reproduce 50x50-inch charts or survey sheets—the largest handled by the department—on one negative instead of four, as was formerly the case. The new instrument does this work with an accuracy of 0.001 or 0.002 inch.

A new book on the selection of belting, hose, and other mechanical rubber goods has been compiled by The B. F. Goodrich Company as a guide to industry generally. Its 21 pages are full of illustrations, tables, engineering data, and useful information on more than 200 of the company's products, besides helpful hints on their installation. For a copy of *A Guide to Selection of Belting, Hose and Other Products* address The B. F. Goodrich Company, Mechanical Division, Akron, Ohio.

Formatite is a new water and oilproof cement that is intended for sealing small surface leaks in tanks and other metal vessels and for making permanent joints in threaded and flanged pipe connections. It is not recommended for joints that must be disconnected frequently. The material is claimed to be especially well suited for use on gasoline and oil lines which are exposed to the weather or to underground water seepage. Key Boiler Equipment Company, 310 South 27th Street, East St. Louis, Ill., puts it up in small collapsible tubes and in cans ranging in size from ½ pint to 1 gallon.

Haynes Stellite Company photo

KEEPING UP THE FLOW

On the theory that a chain is as strong as its weakest link, every part of the cement transport system at Boulder Dam is constructed to resist wear and tear so that service can be maintained. As high as 10,500 barrels of cement are required daily; and the bulk material, after blending, must be delivered to the points of use through a 9-inch pipe line 5,420 feet long. This work is done with compressed air by two Fluxo pumps. The air-valve rings of these pumps are continually exposed to the abrasive action of the fine particles of cement; and that they may do their part in keeping up a steady flow, their inner surfaces are faced, as shown, with a hard cobalt-chromium-tungsten alloy. This protective coating measurably increases their service life.

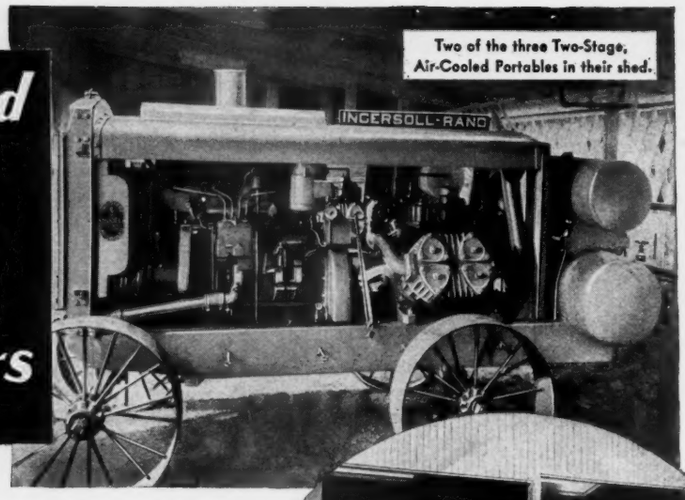
One of the principal objections by workmen to the wearing of goggles is the tendency of the glass to fog, thereby creating discomfort and obscuring vision. This difficulty is particularly pronounced where working spaces are confined, or where the temperature or humidity is high. In an effort to overcome these shortcomings, the American Optical Company of Southbridge, Mass., has produced a new goggle which virtually doubles the area usually provided for ventilation. It is designed not only to reduce fogging but also to prevent perspiration around the eyes. From the standpoint of safety, the new goggle is said to be fully as reliable as any made. It is known as the Duralite-50.

Eel-Slip is a product lately introduced by the Johns-Manville Corporation, and is designed primarily to serve industry in the capacity of a bearing material that can be used without the common lubricants. It is a compound of asbestos, graphite, and rubber, and is said to be tough, to have a low coefficient of friction, to have increased efficiency in the presence of moisture—water being its best lubricant, to possess high wearing qualities, and to lend itself readily to machining. In addition to the making of bearings which run in water or under intermittent dry and wet conditions, the material can be employed for a variety of purposes in paper mills, woodworking plants, etc.

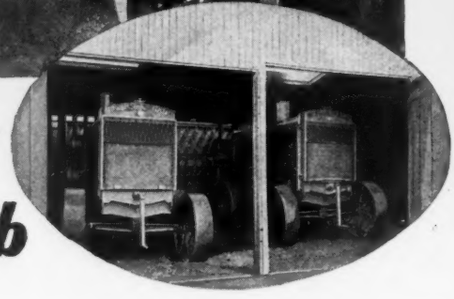
A durable and attractive roofing and siding material of corrugated sheet metal covered with Anaconda electro-sheet copper is produced by H. H. Robertson Company, Pittsburgh, Pa., for the construction of all sorts of industrial buildings and other structures such as hangars, canopies, etc. On exposure it gradually becomes dark brown in color, except along the seaboard where it acquires the characteristic green patina that is so pleasing to the eye. The surface can be painted if desired, preferably with flat paints, but this does not have to be done owing to copper's resistance to rust and corrosion. Because of the corrugations, the material is strong enough structurally to support considerable weight without bracing.

For automatically operating swinging, folding, or sliding doors, or various combinations of such doors, through which there is much traffic, Schoelkopf Manufacturing Company, Madison, Wis., has developed an improved device that it calls Air-Lec and that does its work through the combined pressure of compressed air and a powerful spring. The air opens or closes the door halfway, after which it serves to exert a cushioning effect while the spring takes up and completes the movement, thus preventing slamming and making for speed of operation. The device is controlled electrically through the medium of a simple magnet-valve arrangement, and is set in motion either by hand or by running a vehicle over a driveway switch close to the door. It is said to be easy to install; and is connected with a convenient air line and a 6-volt battery or alternating-current transformer.

3 Ingersoll-Rand Two-Stage Air-Cooled Portable Compressors



Two of the three Two-Stage, Air-Cooled Portables in their shed.



on this "Hairpin" Elimination Job

Two of the I-R wagon drills.

257,058 cubic yards of rock are being excavated and a 318,000-cubic-yard fill is being made in a single mile of road (near Wilkes-Barre, Pa.) to do away with several highly-dangerous curves and grades. The job includes a cut 110 feet deep — a fill 120 feet high.

Three 370-cubic-foot I-R Two-Stage, Air-Cooled Portable Compressors supply the air for I-R wagon-mounted X-71 Drifter Drills. "Jackhamers," "Jackbits," "Jackbit" Rods, "Jackbit" Grinder, and other Ingersoll-Rand tools are in use about 23 hours a day.

Ingersoll-Rand Company, 11 Broadway, New York

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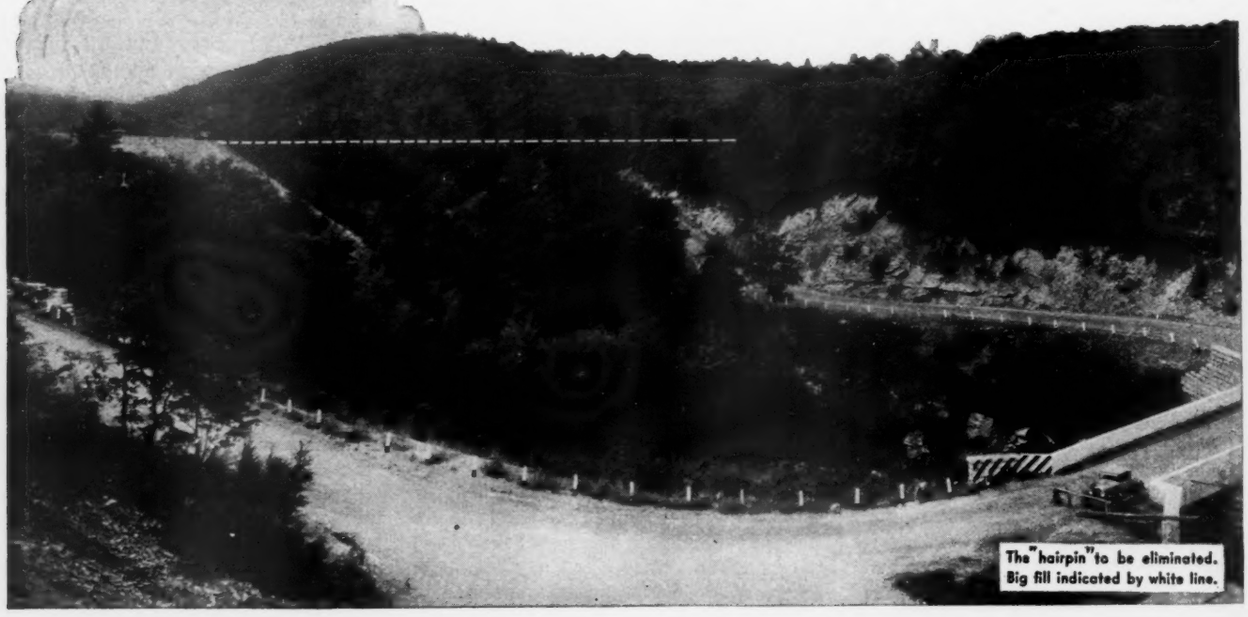
The "hairpin" to be eliminated. Big fill indicated by white line.